CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter provides a detailed analysis and discussion of the probable environmental consequences, or impacts, of implementing each of the three alternatives. The chapter begins with a discussion of methods used to conduct the environmental impact assessment, including general definitions related to the impact analysis. These are followed by a description of the methods used to assess impacts for each impact topic (e.g., air quality, water quality, etc.), including relevant policies, regulations, and assumptions.

Following the sections on impact assessment methodology, the environmental impacts related to each impact topic for Alternatives A, B, and C are comprehensively addressed.

The analysis for each impact topic includes the following:

- Identification of the types of impacts associated with the various actions comprising the alternative;
- Characterization of the impacts, including their duration and intensity;
- Available mitigation measures that would be applied and the effectiveness of these measures on reducing impacts;
- An assessment of cumulative impacts;
- A statement on the potential for implementation of an alternative to impair resources (based on the National Park Service policy on impairment); and
- A conclusion (Conclusions will be the last subsection).

With the exception of the cultural resource analysis, all impacts have been assessed assuming that the mitigation measures that are discussed would be implemented. Cultural resource impact analysis in this EIS is described in terminology consistent with the regulations of the Council on Environmental Quality (CEQ) and will comply with requirements of both the NEPA and Section 106 of the NHPA. The determination of effect for the undertaking (implementation of the alternative) required by the National Park Service Agreement is included in the "conclusion" section of each alternative.

DEFINITION OF TERMS

Three separate aspects of impacts are described for each impact topic for each alternative: the type of impact, the duration of impact, and the intensity of impact. For purposes of this analysis, these aspects are defined as follows:

Type of impact - The type of impact describes the specific elements that could be subject to impacts and the nature of those impacts. Impacts can be either beneficial or adverse.

Duration of impact - The duration of impact describes the relative length of time the impact would affect a given resource. Impacts can be either short-term or long-term, and are defined for

each impact topic in a range of years. It is important to note that an action that has short-term adverse effects on a resource may have long-term beneficial impacts on the same resource.

Intensity of Impact - Identifies the degree to which a resource would be affected by an element of an alternative. Each impact is described as negligible, minor, moderate, or major. These four designations are used for beneficial as well as adverse impacts.

NEPA requires consideration of the direct, indirect, and cumulative impacts of proposed actions. The CEQ regulations (Section 1508.7) define a cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. "Reasonably foreseeable future actions" include planning or development activities that currently are being implemented or would be implemented in the reasonably foreseeable future.

A list of actions that could contribute to cumulative impacts is provided in Appendix C. In the cumulative impact analyses in this EIS, the impacts of these actions are assessed in conjunction with the impacts of each alternative for each impact topic.

In the conclusion section is a statement regarding whether or not implementing the alternative would cause resource impairment. The NPS Organic Act of 1916 and the NPS General Authorities Act 1970, as amended, require park managers to ensure that park resources and park values remain unimpaired. Section 1.4.5 of the NPS Management Policies (NPS, 2000) states: "The impairment that is prohibited by the Organic Act and the General Authorities Act is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values."

The Management Policies further state, "An impact to any park resource or value may constitute an impairment. An impact would be more likely to constitute an impairment to the extent that it affects a resource or value whose conservation is:

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- Identified as a goal in the park's general management plan or other relevant NPS planning documents.

An impact would be less likely to constitute an impairment to the extent that it is an unavoidable result, which cannot reasonably be further mitigated, of an action necessary to preserve or restore the integrity of park resources or values."

REGULATIONS AND METHODOLOGY BY IMPACT TOPIC

Applicable regulations, policies, and methods used to assess the environmental consequences of the three alternatives on the following impact topics are described in the succeeding sections:

- Soils
- Air Quality
- Water Resources and Water Quality
- Vegetation
- Wetlands
- Wildlife
- Special Status Species (e.g., Threatened, Endangered, Rare and Sensitive Species)
- Cultural Resources
- Visitor Use and Visitor Experience
- Park Operations
- Public Health and Safety
- Socioeconomics

Soils

Policies and Regulations
As directed by NPS Management Policies, soil resources are subject to the "no impairment" clause that guides NPS decision-making to protect of the integrity of the important resources and values within the parks (NPS, 2000, §1.4.6). The NPS is directed to protect geologic features from the adverse effects of human activity, while allowing natural processes to continue (NPS, 2000, §4.1.5 and §4.8.2). Management action taken by the parks would prevent to the greatest extent possible the unnatural erosion, physical removal, contamination, and other potentially irreversible impacts to soil (NPS, 2000, §4.8.2.4).

Hydric soils, associated with wetland features such as bogs, marshes, and some wetlands, are afforded special protection by Executive Order 11990, Protection of Wetlands and the Clean Water Act Section 404 as regulated by the U.S. Army Corps of Engineers, and the State Regional Water Quality Control Board. Specific procedural guidance to NPS staff on the protection of wetlands and areas of hydric soils is outlined in Director's Orders 77-1, Wetland Protection. Assessment of potential FMP impacts to hydric soils is addressed as a water quality impact in this document.

The NPS Natural Resource Management Guidelines (Director's Order 77) contain objectives for the protection of soils in the four natural resource management zones used in NPS planning:

Assessment Methodology
The discussion of potential impacts to soils from implementation of the FMP alternatives will address degradation or depletion of soil resources. Sedimentation of creeks and water bodies is addressed under the heading of hydrology/water quality.

Determination of Effect. The primary source for information on Seashore soils is the 1979 Soil Conservation Service Soil Survey of Marin County. With few exceptions, limited information exists on specific baseline biotic, chemical, and compositional condition of the numerous soil units in the park beyond the generalized information provided in the Soil Survey. In this respect, the determination of effect on soils is based on both direct effects to soil resources and inferred from the observation of indirect effects manifested by a change in the vigor of the vegetation supported by soils or a change in the rate of sedimentation in runoff reaching creeks and ponds.

The determination of the degree of impact on soils for the FMP was developed from the direct and repeated field experience of Seashore staff and/or the conservative application of generally accepted research findings on the effects that fire management actions have on soil. These include the reaction of soil resources to both well-established routine activities, such as mechanical clearing and controlled burning, and to non-routine fire suppression actions that vary greatly depending on the specific challenges of each occurrence.

Long-term impacts to soils including changes to soil chemistry, creation of subsurface hydrophobic layers, changes in soil particle composition or mixing, or loss of the soil profile may take years or decades to recover. Short-term impacts are defined as effects to soil processes that are abated through natural processes or aided by use of standard protective practices within four years of the action. Soil productivity and slope stability is regained within this time period. The first winter season following the Vision Fire, runoff and erosion increased in the granitic soils of the Inverness Ridge due to increased hydrophobicity (water repellency) and an overlying crust–like layer. These characteristics diminished following the second year post-fire. Accelerated cutting of stream channels slowed markedly within three years post-fire (B. Ketcham, pers. comm).

Actions with negligible impact are those that are either inherently benign or with effects mitigated to a less than detectable level by the procedural standards, such as erosion control practices, implemented as part of the proposal. Actions with minor impacts would be limited in scope and effect to soils. For example, a low intensity prescribed fire may have several limited affects on soils such as a short-term reduction in protective vegetation cover and consequent slight increase in the rate of soil erosion in an area remote from sensitive water resources.

It is important to assess impacts to soil resources on a system and process level. Watershed scale allows consideration of soil loss and deposition to downstream water resources. Prescribed burns would also likely be designed within a watershed to avoid inclusion of higher, steeper slopes between two watersheds. A stable watershed requires 30% to 50% effective soil cover (ESC) (BAER, 1996). The Forest Service considers a watershed with more than 75% effective ground cover to be in good hydrologic condition wherein only about 2 percent or less of rainfall becomes surface runoff, and erosion is low (Robichaud et. al., 2000).

Effective soil cover includes larger rock fragments, thick leaf litter, plant cover, and mat-forming vegetation in contact with the soil surface. As a conservative threshold with high confidence, impacts to soils within a watershed are deemed minor if FMP actions affect less than 10% of an FMP watershed.

A moderate impact results when more than 10% and less than 25% of the effective soil cover in an FMP watershed is disturbed in one year with impacts to soil resources that are readily correctable by the application of standard erosion control practices. Examples could include a prescribed fire in terrain that gradually slopes that requires erosion control only in limited areas that are oversteepened. Moderate impacts could also result from a wildland fire greater than 10% of a watershed or that required limited use of heavy equipment but burned at a relatively low intensity with little effect on overall soil properties.

Major impacts to soil resources are those that substantially change soil processes or vital soil characteristics in widespread areas of one or more resource watersheds and may trigger related important effects to other park resources such as plants, wildlife, visitor experience, or cultural resource sites. Major impacts to soil resources also include prescribed fire or wildland fire affecting more than 25% of a resource watershed in one year.

Type of Impact

Beneficial: Protects or enhances properties of native soils and promotes or restores natural soil processes.

Adverse: Degrades the characteristics of native soils, exposes soils to accelerated rates of erosion, results in loss of native soils, or contributes to slope failure.

Duration of Impact

Short-term: Impacts are limited to the first four years after treatment or wildland fire.

Long-term Impacts persist four years after treatment or wildland fire.

Intensity of Impact

Negligible: No quantifiable impact and/or reasonably anticipated type of effect based on current knowledge of soil characteristics.

Minor: Fire management actions or incidents of wildland fire confined to plots comprising less than 10% of the total area of an FMP resource watershed wherein rate of post-action erosion can be controlled by standard practices; there is low potential for changes to soil productivity.

Moderate: Fire management actions or wildland fires affecting more than 10% and less than 25% of the total area of an FMP watershed wherein the rate of post-action erosion would be controlled by the application of standard erosion control practices, and little change in soil productivity.

Major: Fire management actions or wildland fires affecting more than 25% of the total area in an FMP watershed or more than 10% of total area of the watershed with impacts that reduce soil productivity or produce rates of erosion that are not readily correctable by best management practices.

Air Quality

Background. Similar to many other national parks near urban areas, the response to wildland fire in the PRNS has been full suppression. One of the results of suppression is the build up of areas of high fuel loading within the park that has increased the potential for a high intensity wildland fire to occur. The events of October 3 – 8, 1995, when the Vision Fire burned 12,354 acres provide a dramatic example of that potential. To address the existing hazard, the fire management program at PRNS has been conducting prescribed burns on several hundred acres within the park each year to reduce fuels in critical areas.

Prescribed burning, proposed in the FMP alternatives, would continue this reduction of high fuel loading within the project area. Continued fuel reduction at key locations would reduce the potential for a large, uncontrollable fire that could generate substantial air pollution emissions and impact regional air quality. As required by the Clean Air Act regional haze provisions, all prescribed fires would continue to be planned and implemented within the Bay Area Air Quality Management District's (BAAQMD) Smoke Management Program.

The air quality assessment will evaluate the potential impacts of pollutants generated by the maximum allowable acreage that can be treated by prescribed burning and mechanical treatment for each FMP alternatives.

Policies and Regulations

National Ambient Air Quality Standards. PRNS is classified as a Class I area under the Clean Air Act (42 USC 7401 et seq.). The Act requires land managers of Class I areas to protect air quality and related values, including visibility, plants, animals, soils, water quality, cultural and historic structures, and visitor health from the effects of air pollution. Values must be protected from any future impairment and remedies sought for any existing impairment from human-caused sources of air pollution. A cooperative program, the Interagency Monitoring of Protected Visual Environments (IMPROVE), between the EPA, federal land managers, and state air agencies, was formed to monitor visibility in the Class I areas.

Data published in a recent IMPROVE report shows that visibility at PRNS improved during the period of 1996 to 1999 primarily due to a decrease in nitrate particulates, a major component of visibility blocking material in coastal California. Particulate nitrate is formed from nitrogen oxide and hydrocarbon gases emitted into the atmosphere from fires, diesel engines, and other sources (Malm, 2000). Monitoring by the NPS found no exceedances for ozone at PRNS under either the California or federal standard. The park air resources are rated as having low exposure to ozone, sulfur, and nitrogen emissions and low potential for acidification of surface waters. A recent NPS report states, "There are no significant air pollution effects concerns in this park [PRNS] at the present time" (Sullivan, et.al., 2001).

The Clean Air Act (CAA) charges the Environmental Protection Agency (EPA) with identifying national ambient air quality standards to protect public health and welfare. Standards have been set for seven pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur

dioxide (SO_2), particulate matter less than 10 microns (PM_{10}), very fine particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and lead (Pb). Section 176 of the Act requires federal actions to conform to state implementation plans for achieving and maintaining the air quality standards. Federal actions cannot cause or contribute to new violations, increase the frequency or severity of any existing violation, interfere with timely attainment or maintenance of a standard, delay emission reduction milestones, or contradict the State Implementation Plan. The conformity rule applies to federal non-attainment areas, such as the Bay Area Air Basin. If a standard is exceeded more than three times in three years in an air basin it is considered a non-attainment area and is then be subject to more stringent planning and pollution control requirements. Table 37 presents the current federal and California ambient air quality standards.

Table 37. Ambient Air Quality Standards & Bay Area Attainment Status

Pollutant	Averaging Time	California Standards[1]		National Standards[2]	
		Concentration	Attainment Status	Concentration[3]	Attainment Status
Ozone (O^3)	8 Hour			0.08 ppm	N
	1 Hour	0.09 ppm (180 µg/m^3)	N	0.12 ppm (235µg/m^3)	N[4]
Carbon Monoxide (CO)	8 Hour	9.0 ppm (10 mg/m^3)	A	9 ppm (10 mg/m^3)	A[5]
	1 Hour	20 ppm (23 mg/m^3)	A	35 ppm (40 mg/m^3)	A
Nitrogen Dioxide (NO_2)	Annual Average			0.053 ppm (100 µg/m^3)	A
	1 Hour	0.25 ppm (470 µg/m^3)	A		
Sulfur Dioxide (SO_2)	Annual Average			80 µg/m^3 (0.03 ppm)	A
	24 Hour	0.04 ppm (105 µg/m^3)	A	365 µg/m^3 (0.14 ppm)	A
	1 Hour	0.25 ppm (655 µg/m^3)	A		
Particulate Matter (PM_{10})	Annual Arithmetic Mean	20 µg/m^3	N[6]	50 µg/m^3	A
	24 Hour	50 µg/m^3	N	150 µg/m^3	U
Particulate Matter - Fine ($PM_{2.5}$)	Annual Arithmetic Mean	12 µg/m^3	N[6]	15 µg/m^3	U
	24 Hour			65 µg/m^3	U
Sulfates	24 Hour	25 µg/m^3	A		
Lead (Pb)	Calendar Quarter			1.5 µg/m^3	A
	30 Day Average	1.5 µg/m^3	A		
Hydrogen Sulfide	1 Hour	0.03 ppm (42 µg/m^3)	U		
Vinyl Chloride (chloroethene)	24 Hour	0.010 ppm (26 µg/m^3)	No information available		

Visibility Reducing particles	8 Hour (1000 to 1800 PST)	(See note 7)	A	

A=Attainment N=Nonattainment U=Unclassified

ppm=parts per million mg/m3=milligrams per cubic meter µg/m3=micrograms per cubic meter

[1] California standards for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, suspended particulate matter - PM_{10}, and visibility reducing particles are values that are not to be exceeded. The standards for sulfates, Lake Tahoe carbon monoxide, lead, hydrogen sulfide, and vinyl chloride are not to be equaled or exceeded. If the standard is for a 1-hour, 8-hour or 24-hour average (i.e., all standards except for lead and the PM_{10} annual standard), then some measurements may be excluded. In particular, measurements are excluded that ARB determines would occur less than once per year on the average. The Lake Tahoe CO standard is 6.0 ppm, a level one-half the national standard and two-thirds the state standard.

[2.] National standards other than for ozone, particulates and those based on annual averages are not to be exceeded more than once a year. The 1-hour ozone standard is attained if, during the most recent three-year period, the average number of days per year with maximum hourly concentrations above the standard is equal to or less than one. The 8-hour ozone standard is attained when the 3-year average of the 4th highest daily concentrations is 0.08 ppm or less. The 24-hour PM_{10} standard is attained when the 3-year average of the 99th percentile of monitored concentrations is less than 150 µg/m3. The 24-hour $PM_{2.5}$ standard is attained when the 3-year average of 98th percentiles is less than 65 $\mu g/m^3$.

Except for the national particulate standards, annual standards are met if the annual average falls below the standard at every site. The national annual particulate standard for PM_{10} is met if the 3-year average falls below the standard at every site. The annual $PM_{2.5}$ standard is met if the 3-year average of annual averages spatially-averaged across officially designed clusters of sites falls below the standard.

[3.] National air quality standards are set at levels determined to be protective of public health with an adequate margin of safety. Each state must attain these standards no later than three years after that state's implementation plan is approved by the Environmental Protection Agency.

[4.] In August 1998, the Bay Area was redesignated to nonattainment-unclassified for the national 1-hour ozone standard.

[5.] In April 1998, the Bay Area was redesignated to attainment for the national 8-hour carbon monoxide standard.

[6.] In June 2002, CARB established new annual standards for $PM_{2.5}$ and PM_{10}.

[7.] Statewide VRP Standard (except Lake Tahoe Air Basin): Particles in sufficient amount to produce an extinction coefficient of 0.23 per kilometer when the relative humidity is less than 70 percent. This standard is intended to limit the frequency and severity of visibility impairment due to regional haze and is equivalent to a 10-mile nominal visual range.

Source: http://www.baaqmd.gov/pln/ambientairquality.asp. Updated January 2003.

The EPA has developed regional haze regulations to improve visibility or visual air quality in national parks and wilderness areas across the country (EPA, 1999). In developing these rules, the EPA recognized that both prescribed and wildland fires contribute to regional haze; that there is a complex relationship between what is considered a natural source of fire versus a human-caused source of fire. In many instances, the purpose of prescribed fires is to restore the natural fire regime to forest ecosystems to prevent future catastrophic fires that can detrimentally affect air basin air quality. The EPA works to support state and federal land managers in the development of enhanced smoke management plans to minimize the effects of fire emissions from prescribed fires on pubic health and welfare.

California Ambient Air Quality Standards. The Federal Government has ceded responsibility and authority to establish air quality standards and regulations to the States. Therefore all NPS areas

are required to comply with state laws on these matters regardless of the type of legal jurisdiction that applies to other activities within the NPS unit.

To protect public health and welfare, the California Air Resources Board (CARB) has set stricter ambient air quality standards than national standards. Under the 1988 California Clean Air Act, air basins were designated as attainment, non-attainment, or unclassified for the state standards.

State implementation plans identify measures designed to bring non-attainment areas into attainment. Basic components of state implementation plans include legal authority, an emissions inventory, an air quality monitoring network, control strategy demonstration modeling, emission limiting regulations, new source review provisions, enforcement and surveillance strategies, and other programs necessary to attain standards.

The CARB is responsible for disseminating regulations about air quality, including state ambient air quality standards and area designations, emissions from motor vehicles, fuels and consumer products, and airborne toxic control measures. Title 17 of the California Code of Regulations, titled Smoke Management Guidelines for Agricultural and Prescribed Burning, provides direction to air pollution control and air quality management districts for the regulation and control of agricultural burning, which includes prescribed burning. The guidelines are intended to allow the use of prescribed burning as a management tool, while minimizing smoke impacts on the public.

San Francisco Bay Area Air Quality Management District (BAAQMD). BAAQMD is the air quality management district for the project area and has primary responsibility for control of air pollution from prescribed burning. BAAQMD has procedures that must be followed prior to implementation of a prescribed burn plan. For all prescribed fires, BAAQMD requires submission of the individual burn plan at least one month prior to the proposed burn. BAAQMD then issues a forecast 72-hours prior to the proposed date and gives a final commitment to permit the burn on the day of the burn itself, though forecasts with increasing confidence can be obtained at 96-hours, 72-hours, 48-hours, and 24-hours prior to the burn day to support moving forward on all the logistical planning needed to conduct a prescribed burn.

National Park Service Guidance and Policies. NPS Management Policies direct superintendents to comply with all federal, state, and local air quality regulations and permitting requirements when conducting prescribed burns (NPS, 2000, §4.7.1.). In addition to the requirements of the CAA, specific guidance has been developed by the EPA to address prescribed burning. These are supplemented by guidance and policies such as the Federal Wildland Fire Management Policy and the EPA's Interim Air Quality Policy on Wildland and Prescribed Fires. These policies direct federal agencies to consider ambient air quality below the national ambient air quality standards for $PM_{2.5}$ and PM_{10} as the principal indicator of adverse impacts to public health. Poor visibility is used as the principal indicator of adverse impact to public welfare. The Natural Events Policy addresses public health impacts from wildland fires.

An objective of CARB and NPS directives is to minimize smoke impacts on people and on sensitive receptors in and near national parks. Sensitive receptors can include towns, villages, hospitals, schools, nursing homes, campgrounds, trails, scenic vistas, and Class I areas such as

PRNS. Selection of sensitive receptors is based on guidance from the California Code of Regulations Title 17, Smoke Management Guidelines for Agricultural and Prescribed Burning, and through consideration of the local setting including demographics, wind patterns, and local climatic conditions.

NPS-77 (Natural Resource Management Guidelines) states: "The National Park Service will seek to perpetuate the best possible air quality in parks because of its critical importance to visitor enjoyment, human health, scenic vistas, and the preservation of natural systems and cultural resources. The Park Service will assume an aggressive role in promoting and pursuing measures to safeguard [air quality related values] from the adverse impacts of air pollution. In cases of doubt as to the impacts of existing or potential air pollution on park resources, the Park Service will err on the side of protecting air quality and related values for future generations."

Assessment Methodology

Fire management actions could affect air quality in the project area through smoke emissions from wildland and prescribed fires, and from exhaust generated by machinery used in site preparation for prescribed burns, mechanical fuel reduction projects and suppression activities.

Method of Estimating Smoke Emission. The First Order Fire Effects Model 5.0 (FOFEM) was used to generate emission factors for PM_{10}, $PM_{2.5}$, volatile organic compounds (VOC), CO (carbon monoxide), and CO_2 (carbon dioxide) for the maximum allowable fire management actions under each alternative. FOFEM is a computer-based model that provides quantitative predictions for planning prescribed fires, conducting impact assessments, and for long-range planning and policy development. FOFEM is the standard modeling program used to demonstrate conformity with applicable environmental impact rules and regulations. The model also provides fire effects information on potential tree mortality, fuel consumption, mineral soil exposure, and smoke generation (Reinhardt, 1997). The smoke module of FOFEM does not predict smoke dispersion or model the impairment of local visibility.

The FOFEM smoke module requires a number of inputs related to burn characteristics such as fuel category, cover type, fuel loading, moisture content, and percent of crown burn. For this assessment, PRNS fire management staff described representative burn parameters for each burn unit. The area of each cover type in a given prescribed burn unit was determined based on the expertise of the fire management staff draft and vegetation mapping of the project area. The burn unit cover types were then correlated with the Society for American Foresters (SAF)/Society for Range Management (SRM) vegetation types for use in the FOFEM model. Where a direct correlation between cover types was not possible, a surrogate SAF/SRM cover type was selected. Table 38 provides a cross-reference for cover types.

Table 38. Vegetation Cover Types Used in Air Quality Emissions Analysis

FM Vegetation Class	SAF[1]/SRM[2] Type
Valley grassland, Annual grassland	SRM 208
Ceanothus, mixed chaparral	SRM 215
Pacific Douglas-fir	SAF 229

[1]Society for American Foresters (SAF) [2]Society for Range Management (SRM)

The results of the FOFEM model were used to develop average emission factors (per acre) that are used to quantify the amount of pollutants generated by the maximum prescription burning allowed for each alternative. For a given prescribed burn unit and pollutant, the emissions were quantified by the following equation:

$$E = \sum_{c=1}^{n} EFc * Ac, \text{ where}$$

E = emissions in tons/year
Efc = emission factor for coverage c in tons/acre
Ac = area of coverage in acres

Separate FOFEM runs were used to develop emission factors for wildland fires, since these typically burn under drier conditions and consume more fuel, particularly crown and branch fuels, and produce higher emissions. PRNS staff provided burn parameters based on recent wildland fires to model these emissions.

Both the prescribed and wildland fire emission factors predicted by FOFEM are higher than similar emission factors in the EPA's Compilation of Air Pollution Emission Factors (AP-42) for the same region. However, the AP-42 derived emission factors are generalized for large regions and "can vary by as much as 50 percent with fuel and fire conditions" (EPA, 1996). Since fuel loading in many areas of PRNS may be heavier than normal due to decades of fire suppression, the emission factors used here can be considered better represent PRNS conditions.

FOFEM does not provide emission factors for nitrogen oxide (NOx). According to EPA AP-42, the emission factors for NOx from wildland and prescribed fires are approximately 35 times less than those for CO emissions. Therefore, the CO emission factors produced by the FOFEM model were scaled down proportionately to estimate NOx emission factors. Table 39 provides the emission factors used for each fire type.

Table 39. Smoke Emission Factors by Fire Type

		EMISSION FACTOR (LBS/ACRE)[1]				
Fire type	Ecosystem	PM_{10}	$PM_{2.5}$	VOC (CH_4)	CO	NOx
Prescribed Fire	grass[2]	11	9	3	23	1
	brush[3]	190	161	49	404	12
Understory Fire	forest[4]	5,046	4,276	2,595	56,899	1,626
Low Intensity	grass[2]	11	9	3	23	1
Wildfire	brush[3]	190	161	49	404	12
	forest[4]	3,430	2,907	1,760	38,524	1,101
High Intensity	grass[2]	11	9	3	23	1
Wildfire	brush[3]	190	161	49	404	12
	forest[4]	5,108	4,329	2,622	57,419	1,641

Notes

1. PM_{10} = Suspended Particulate Matter, $PM_{2.5}$ = Fine Particulate Matter, CH_4 = Methane , CO = Carbon Monoxide, NOx = Nitrogen Oxides
2. Grass = SRM 208 vegetation areas
3. Brush = SRM 215 vegetation areas
4. Forest = SAF 229 vegetation areas

Annual inputs for wildland fire is based on 30 acres burned per year during 3 to 5 fire starts, a conservative estimate of wildland fire in the PRNS according to the PORE Fire Management Officer (pers. comm. Roger Wong, 7/29/03). The wildfire acreage is split up as 20 acres of grassland, 8 acres of shrubland, and 2 forested acres. The low incidence and limited acreage of wildland fire annually in the study area is due primarily to a very low incidence of deliberate fire starts on the part of the public and the wetter than usual summertime conditions of western Marin. The 30-acres of wildfire is consistent throughout the alternatives. Therefore, the difference in estimated annual emissions in the three alternatives is based on the maximum allowable prescribed fire under each.

Emissions Modeling for Each Alternative. The results of the FOFEM representative burn analyses were interpreted to estimate the annual air pollutant emissions for each alternative, and also to estimate the emissions for the cumulative impact scenario under each alternative. To provide comparisons of the emissions under each alternative, the FOFEM model simulations was used to estimate the annual average emissions, and cumulative impact emissions from a conceivable catastrophic fire on the order of the 1995 Vision Fire.

Conditions in the study area are such that the potential exists for the recurrence of a large, quick burning fire such as the Mt. Vision Fire of October 1995. Research into fire history in the park finds an absence of fire in lake sediments representing the last century. The fire interval in the Douglas-fir forests before suppression may have been every 7 to 15 years. As the potential exists in the project area for the reoccurrence of a large-scale wildfire, the acreage and burn regime of the 1995 Vision Fire (12,354 acres) is used as the basis from which to judge cumulative effects. The cumulative scenario for air quality impacts consists of annual project impacts plus the emissions generated by other reasonably foreseeable projects or events, such as a catastrophic fire, and the continuation of WUI projects in the communities adjacent to the project area.

If an increased level of prescribed burning and mechanical treatment is implemented, as considered under each of the action alternatives, there would be a transition period while the new fuel reduction program is being implemented, during which the annual emissions would increase due to increased prescribed burning. As more and more fuels are treated, the potential for a catastrophic fire with associated significant emissions gradually decreases as the risk declines with more and more pro-active vegetation treatment each year. That transition period would eventually lead to the desired long-term regime, where annual emissions would remain near the current long-term average, but the chance for large wildfires would be significantly diminished. The more acreage is treated annually, the faster the desired long-term stability regime is reached.

To more accurately portray cumulative effects over the life of FMP implementation, the modeled scenario for each alternative compares average emissions generated during the transition period and emissions generated when a more natural fire regime is re-established and a more stable fire ecology is achieved. During transition, the aggregate of acreage treated results in a probable decrease in the median size of a potential wildfire. For the 1000-acre alternative (Alternative B), the cumulative effect during the transition period is based on the mid-way point of the transition – year 12 – that assumes a 5000-acre wildfire instead of a wildfire of the scale of the Vision Fire. The transition period for Alternative C, with the 2000 acres of prescribed burning, a 3500-acre wildfire is the basis of the assessment.

Emissions from Mechanical Treatments

Air pollutants would be generated during the larger fuel reduction projects and during thinning prior to understory burns and site preparation for prescribed burns. Motorized equipment used in thinning and site preparation activities could include chainsaws, mowers, skidders, and haul trucks. These types of equipment are a representative sample of the types of equipment used in PRNS. Emissions associated with the use of motorized equipment were estimated for each alternative. Table 40 shows the AP-42 factors used to calculate emissions for the alternatives.

Table 40. Emission Factors for Equipment Use in Fire Management Activities

Operating Parameters			**Emission Factor (lbs/hour)1**			
Machine Type	Fuel Type	Average HP	CO	PM	NOx	VOC
Chainsaw	Gasoline	6	3.4	0.05	0.01	1.1
Mower	Gasoline	50	30.6	0.26	0.26	0.39
Skidder	Diesel	200	4.4	0.57	3.0	0.95
Haul truck	Diesel	200	4.4	0.57	3.0	0.95

Average HP = Average horsepower, CO = Carbon Monoxide, PM = particulate matter, NOx = Nitrogen Oxides, VOC = Volatile Organic Compounds (total hydrocarbons) such as methane (CH_4).

An assessment of the emissions from all mechanical treatment activities was prepared for each alternative. Mechanical emissions were calculated on a per acre basis based upon estimates from fire program managers on activity levels for each type of equipment under each fire scenario and ecosystem. Those emissions were generally a small contribution to ambient smoke emissions being modeled at the site.

Air Quality Descriptors

Type of Effect.

Beneficial: Improves or maintains air quality while lowering the potential for significant short-term pollutant release events

Adverse: Degrades current air quality.

Duration of Effect and Cumulative Impacts. The behavior of a smoke plume from a fire, including the direction and elevation that the smoke plume moves, and resulting concentrations at ground level, is highly dependent on elevation and dynamic meteorological conditions at the time. Under prescription conditions, air quality emissions generated by prescribed burning or other fire management actions would disperse within a time frame roughly the same as the duration of the fire management action. An exception to this would be if smoke from a wildfire became trapped at low altitudes in an inversion layer that can occur in the fall or winter.

The emissions contributed annually by all actions under each alternative represent new, long-term contributions to regional haze. To achieve the goals of the PRNS FMP, the potential for a large-scale fire should be reduced or the scale of the potential fire should be reduced. The emissions contributed by the potential large-scale catastrophic fire represent the cumulative air quality scenario for the FMP assessment. The fire management plan should reduce the level of hazard of a catastrophic fire over the course of implementation of the plan. Eventually, the level of hazard would revert to a more natural fire return interval. During this period of progressively reducing cumulative effect, project implementation effects remain stable as the same amount of acreage is treated each year.

Short-term Effects on air quality last less than 3 days beyond the duration of the fire management action.

Long-term Effects on air quality persist beyond the duration of the fire management actions contributing additional pollutants to the air basin on an annual basis.

Intensity of Effect: Localized Effects of Smoke

Negligible: Smoke would be barely perceptible or detectable and affect an undeveloped area (no recreational facilities or trails, no habitable structures, etc.).

Minor: Smoke would be detectable but localized within an area of low-density development for recreational or private use, of short duration (several hours), and have no lasting effects.

Moderate: Smoke would be readily perceptible but localized in an area of low-density development, be sufficient to limit use of the area for one day or less without damage to property or lasting effect.

Major: Smoke would be readily noticeable, occur in a developed area with a potential hazard to human health or creating property damage or lasting effect.

Intensity of Effect: Regional Haze.

As defined by the federal Clean Air Act and 1977 amendments, Point Reyes is a Class I airshed where visibility – the ability to see clearly across great distances and appreciate natural landscapes - must be protected from degradation (Malm, 2000). The increase in particulate matter and certain gases are the greatest influences on impairment of airshed visibility. As Point Reyes is in closer proximity to a heavily populated area than many national parks, regional haze is a very high concern. BAAQMD has adopted a Smoke Management Program to minimize regional haze and the PRNS FMP must conform to the requirements of that Program. The assessment of the annual average effect on air quality of the FMP alternatives is based on generation of particulate matter to reflect the potential contribution of FMP actions to regional haze. [Note: Management acres are equal to the extent of the full project area for the FMP (90,000 acres). Impact intensity is calculated based on emissions per acre/90,000.]

Negligible: All FMP actions generate less than 1 lb. PM_{10} annually per acre managed does.

Minor: All FMP actions generate less than 5 lbs. PM_{10} annually per acre managed.

Moderate: All FMP actions generate less than 10 lbs. PM_{10} annually per acre managed.

Major: All FMP actions generate more than 10 lbs. PM_{10} annually per acre managed.

Cumulative Impacts, Intensity of Effect.

The intensity of cumulative impact for each alternative is assessed in comparison to the emissions that could be generated by a catastrophic fire (Vision Fire scale event) under Alternative A. This large-scale fire is modeled after the vegetation type and acreage affected by the 1995 Vision Fire. The following categories will be used to describe the intensity of the air quality impact at Year 1 and Year 10 of implementation of the FMP alternative.

Negligible: Equal or greater than emissions generated by a Vision Fire-scale wildfire event.

Minor: 5 to 20% change in emissions compared to the Vision Fire-scale fire event.

Moderate: 21 to 50% change in emissions compared to the Vision Fire-scale fire event.

Major: More than 50% change in emissions compared to the Vision Fire-scale fire event.

Water Resources and Water Quality

Policies and Regulations

The Clean Water Act requires the NPS to "comply with all Federal, State, interstate, and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water pollution." The NPS Freshwater Resource Management Guidelines (found in NPS-77) requires the NPS to "maintain, rehabilitate, and perpetuate the inherent integrity of water resources and aquatic ecosystems."

NPS Management Policies 2000 states: "The Service will manage watersheds as complete hydrologic systems, and will minimize human disturbance to the natural upland processes that deliver water, sediment, and woody debris to streams. These processes include runoff, erosion, and disturbance to vegetation and soil caused by fire, insects, meteorological events, and mass movement. The Service will achieve the protection of watershed and stream features primarily by avoiding impacts to watershed and riparian vegetation, and by allowing natural fluvial processes to proceed unimpeded."

Assessment Methodology

The following three primary aspects of water resources were assessed when considering potential impacts:

- Hydrology of the project area,
- Aquatic habitat within the project area, and
- Water quality.

Hydrology refers to hydrologic processes such as flooding, erosion, deposition, and maintenance of channel patterns. Aquatic habitat refers to the attributes that support or provide habitat within stream or pond systems. Water quality refers to the suitability of surface water for beneficial use, including cold-water or warm-water aquatic wildlife habitat and recreational use. Particular consideration was given to actions with potential to affect the natural hydrology, aquatic habitat features, and surface water quality of cold-water streams.

The San Francisco Bay Regional Water Quality Control Board (RWQCB) has listed Tomales Bay and its major watersheds, Lagunitas Creek and Walker Creek, as impacted by sediment, nutrients, and pathogens under Section 303 (d) of the Clean Water Act. In addition, the RWQCB has also listed Tomales Bay and Walker Creek as impaired by mercury. The RWQCB is required by the EPA to develop and implement TMDLs for each pollutant parameter by 2010.

Specific watersheds supporting cold-water aquatic habitat include Lagunitas Creek, Olema Creek, Pine Gulch Creek, and most coastal drainages originating from Inverness Ridge.

The Arroyo Hondo and upper Haggerty Gulch watersheds provide water supply to the Bolinas Community Public Utility District, and a few park residences near the Limantour Road. These

water supply diversions are permitted through the State Water Resources Control Board and are agreed to by the NPS and associated water users.

Type of Impact

Adverse: would alter natural hydrologic conditions (e.g., impede flood flows, cause unnatural erosion or deposition, etc.); degrade water quality (e.g., increase pollution or bacteria levels from recreational use); or degrade aquatic habitat.

Beneficial: would restore natural hydrologic conditions (e.g., remove impediments to flood flows, stabilize riverbanks, etc.); improve water quality (e.g., reduce non-point source pollution); or improve or maintain aquatic habitat.

Duration of Impact

Short-term: would last two years or less.

Long-term: would last longer than two years.

Note: Since full implementation of an alternative would take place over a number of years, this section considers the duration of individual actions within each alternative (e.g., mechanical treatment of a specific area) instead of full implementation of the alternative.

Intensity of Impact

Negligible: would be imperceptible or not detectable.

Minor: would be slightly perceptible, without the potential to expand if left alone; and would be localized (i.e., would occur in the immediate vicinity of an action).

Moderate: would be apparent and would have the potential to become larger.

Major: would be substantial, highly noticeable, and regional (i.e., would occur over a large area, such as the Tomales Bay watershed, or the Point Reyes National Seashore). Many water quality impacts are regional because an action could potentially affect water quality downstream.

Vegetation

Policies and Regulations

NPS Management Policies 2001 state "The National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals." The policies go on to state that the above statement includes flowering plants, ferns, mosses, lichens, algae, fungi, and microscopic plants. The NPS is to preserve and restore the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of these native species. Additionally, the NPS is to prevent the introduction of exotic (non-native) species into units of the National Park System. The policy manual NPS-77 (Natural Resource Management Guidelines) also provides general guidelines on vegetation management.

Assessment Methodology

Vegetation in the project area was digitally mapped using aerial photographs in 1999/2000. Field data on plant species composition were collected to characterize and classify plant communities delineated in the mapping effort. The classification describes the vegetation alliances and associations that occur in the study area, and was initially based on the classification system described by Sawyer and Keeler-Wolf. For purposes of this document, alliances and associations found in the project area have been grouped together into 10 broad vegetation classes that are described in Chapter 3 (Affected Environment). The alliances and associations that are grouped into a given vegetation class all share species with similar growth forms and structural attributes, thus it is assumed that they would respond similarly to treatments that would be applied under the FMP. The aerial extent of each vegetation class within each FMU was derived from the Seashore's GIS.

The primary assessment of impacts on vegetation considers potential impacts of fire management activities on all vegetation, regardless of vegetation class. This is followed by special considerations and impacts unique to individual vegetation classes. The following parameters were considered when assessing impacts on individual vegetation classes:

- fire ecology of the dominant species in the vegetation class,
- past and present fire regimes of the vegetation class,
- aerial extent and relative abundance or rarity of the vegetation class in the project area and in the region, and
- abundance and species richness of non-native plants within, or adjacent to the vegetation classes affected.

The abundance, as defined by aerial extent, of an individual vegetation class is important when considering impacts because the Seashore is mandated to protect and maintain all native plant communities. If a vegetation class is very rare in the project area or the region, such as riparian woodland, adverse impacts to the vegetation class may be more significant.

The presence and abundance of non-native (or exotic) plants in the affected vegetation classes is an important consideration as many non-native plant species are stimulated to grow and reproduce as a result of fire or other disturbance. The presence of some non-native plant species can have substantial adverse effects on native vegetation, including the following:

- they can out-compete native plants for light, nutrients, water and growing space, which, in the worst case, can lead to extinction or local extirpation of rare plant species;
- they can degrade the quality of wildlife habitat by out-competing native food sources, or altering nesting or resting habitat;
- they can disrupt the genetic integrity of native plants if crossbreeding occurs; and
- they can change fire regimes by converting habitat types (e.g., conversion of a shrub or forested landscape with little understory to one that has a continuous herbaceous layer).

Much of the information on individual vegetation classes focuses on the dominant species within the classes, and the effects of fire on these species. Information on individual plant species largely was derived from the following source: U.S. Department of Agriculture (USDA), Forest

Service, Rocky Mountain Research Station, Fire Sciences Laboratory (U.S. Department of Agriculture, 2003). Fire Effects Information System (FEIS) is available online at: http://www.fs.fed.us/database/feis/, and includes comprehensive bibliographies for each species. Frequently referenced documents also are included in the References section of this EIS.

Type, duration, and intensity of vegetation impacts are described as follows:

Type of Impact

Adverse: decreases the aerial extent or native species richness of a plant community, results in a plant community type conversion, or increases invasive non-native plant species abundance or richness.

Beneficial: increases the aerial extent or native species richness of a plant community, or decreases invasive non-native plant species abundance or richness.

Duration of Impact

Short-term: would be measurable for two years or less.

Long-term: would be measurable for longer than two years.

Intensity of Impact

Intensity of impact was determined for the various fire management activities by considering the degree to which such activities would affect the aerial extent of plant communities, or would change the abundance or species richness of native or non-native plant species within plant communities.

Negligible: would result in no measurable changes in aerial extent, or in native or non-native species richness within a plant community.

Minor: changes in aerial extent, or in native or non-native species richness within a plant community would be measurable, and would affect less than 5% of the total extent of that plant community in the project area.

Moderate: changes in aerial extent, or in native or non-native species richness within a plant community would be measurable, and would affect from 5 to 25% of the total extent of that plant community in the project area.

Major: changes in aerial extent, or in native or non-native species richness within a plant community would be measurable, and would affect 25% or more of the total extent of that plant community in the project area.

Wetlands

Policies and Regulations

Wetlands are addressed separately from other vegetation types in this impact analysis as they are protected by a specific set of laws and regulations. Wetlands are lands that are transitional

between terrestrial and aquatic systems, where the water table is usually at or near the surface, or the land is covered by shallow water. Wetlands buffer the effects of hydrologic and erosional cycles, influence biogeochemical cycles of nitrogen and other key nutrients, and create unique microclimates for animal and plant species.

The protection of wetlands within NPS units is facilitated through the following:

- Executive Order 11990, Protection of Wetlands.
- NPS Director's Order 77-1, Wetland Protection and its accompanying Procedural Manual 77-1 (DO 77-1 and PM 77-1).
- Rivers and Harbors Act, Section 10.
- Clean Water Act, Section 404.
- The "no net loss" goal outlined by the White House Office on Environmental Policy in 1993.

Executive Order 11990 requires that agencies work to minimize the destruction, loss, or degradation of wetlands. Director's Order 77-1 and Procedural Manual 77-1 provide specific procedures for implementing Executive Order 11990. Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act authorize the U.S. Army Corps of Engineers to grant permits for construction and disposal of dredged material in waters of the United States, which includes wetlands.

Assessment Methodology

For this assessment, wetlands that could be subject to impacts were identified using National Wetlands Inventory (NWI) information (USFWS, 1984), enhanced wetland mapping data recently acquired through intensive field inventory efforts, and information from the Seashore's vegetation map (NPS, 2001). These data layers then were overlain with the boundaries of the 10 fire management units. This information provided a conservative and broad estimate of the extent of known and potential wetlands within the planning area. The approximate number of acres that would be subject to impacts was estimated using the Seashore's GIS.

The parameters that were considered in the assessment of impacts on wetlands include the following:

- plant species composition of the wetland, including abundance and species richness of invasive non-native plant species;
- hydrologic features that maintain the wetland; and
- wetland soils.

These parameters parallel those used by the Army Corps of Engineers when defining wetlands. It is assumed that if these parameters are altered as a result of fire management activities, the wetland would be subject to impacts, which could be either beneficial or adverse.

Type, duration, and intensity of wetlands impacts are described as follows:

Type of Impact

Adverse: Shifts plant species composition to a higher percentage of non-wetland indicator species; alters hydrologic features/factors that are required to maintain the wetland; alters soil properties that are required to maintain the wetland; or reduces aerial extent of wetlands.

Beneficial: Enhances wetland vegetation, soils, or hydrology, or increases aerial extent of wetlands.

Duration of Impact

Short-term: would be measurable for two years or less.

Long-term: would be measurable for longer than two years.

Intensity of Impact

Negligible: would result in no measurable changes in the aerial extent of wetlands, or in wetland vegetation, soils, or hydrology.

Minor: changes in the aerial extent, or in wetland vegetation, soils or hydrology would be measurable but would affect less than 5% of the total extent of the wetland type in the project area.

Moderate: changes in the aerial extent, or in wetland vegetation, soils or hydrology would be measurable but would affect less than 20% of the total extent of the wetland type in the project area.

Major: changes in the aerial extent, or in wetland vegetation, soils or hydrology would be measurable and would affect 20% or more of the total extent of the plant community in the project area.

Wildlife

Policies and Regulations

NPS Management Policies 2001 state: "The National Park Service will maintain as parts of the natural ecosystems of parks all native plants and animals." The policy statement includes bacteria, mammals, birds, reptiles, amphibians, fishes, arthropods, worms, and microscopic animals. The NPS is to preserve and restore the natural abundance, diversities, dynamics, distributions, habitats, and behaviors of these native species. Additionally, the NPS is to prevent the introduction of exotic (non-native) species into units of the National Park System. The policy manual NPS-77 (Natural Resource Management Guidelines) also provides general guidelines on wildlife management.

The NPS also is required to comply with the Fish and Wildlife Coordination Act; the Marine Mammal Protection Act; the Bald and Golden Eagles Protection Act; the Wilderness Act; the Convention on International Trade in Endangered Species; and maritime and other international agreements. The NPS also is required to comply with The Migratory Bird Treaty Act (1918) as

amended, which prohibits taking, killing, or possessing migratory birds, nests, or eggs. As a refuge for tule elk, Point Reyes National Seashore is directed to participate in a Federal/State cooperative program for preservation and enhancement of tule elk in California under the Tule Elk Preservation Act (1976).

Assessment Methodology

Many wildlife concerns can be addressed by considering the effects of actions on wildlife habitat as represented by general vegetation types. In general, adverse effects on wildlife can be minimized by reducing and limiting habitat fragmentation; that is, by preserving and restoring large areas as well as patches of habitat, and maintaining connections within and among habitat types. Larger patches of habitat tend to support higher numbers and diversity of wildlife species than smaller ones, and connections between habitat patches enable the movement of wildlife between areas, enhancing reproduction and survival. Small patches of habitat can serve as stepping-stones for wildlife moving between larger blocks.

The value of habitat patches for wildlife is also affected by adjacent human activities and development. Severe disruption of habitat corridors can impede wildlife movements. Impacts radiating into habitat patches, such as noise, non-native species, and human use, can adversely affect habitat quality. Wildlife tend to prefer a core of habitat that is more isolated from radiating impacts.

Impacts on wildlife have been assessed in terms of the following:

- Changes in the amount and distribution of wildlife habitat;
- Changes in the size and connectivity of habitat patches; and
- The existing integrity/quality of affected habitats (including past disturbances), and the relative importance of affected habitats.

Type of Impact

Adverse: would negatively affect the size, continuity, or integrity of wildlife habitat.

Beneficial: would positively affect the size, continuity, or integrity of wildlife habitat.

Duration of Impact

Long-term: would last two years or longer.

Short-term: would be expected to last for less than two years.

Intensity of Impact

Negligible: would not be measurable or perceptible.

Minor: would be measurable or perceptible and would be localized within a relatively small area; however, the overall viability of the resource would not be affected. Without further impacts, minor adverse effects would be reversed, and the resource would recover.

Moderate: would be sufficient to cause a change in the resource (e.g., abundance, distribution, quantity, or quality); however, the impact would remain localized. The change would be measurable, but negative effects could be reversed in the long-term.

Major: would be substantial, highly noticeable, measurable, and could be irreversible (permanent). The resource would be unlikely to recover.

Special-Status Species

Policies and Regulations

Numerous species of plants and animals have undergone local, state, or national declines, which has raised concerns about their possible extinction if they are not protected. As a result, the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG) have established lists that reflect the species' status and the need for monitoring, protection, and recovery. In addition to federal and state-listed species, potential impacts on plants listed by the California Native Plant Society (CNPS) also are considered for all programs and activities that the Seashore undertakes. The Seashore also recognizes a number of species as locally rare or of special concern, even though they are not officially listed. Collectively, species in all of these categories are referred to in this document as "special-status species."

The Federal Endangered Species Act (ESA) of 1973, as amended, requires federal agencies to consult with the USFWS before taking actions that (1) could jeopardize the continued existence of any federally listed plant or animal species (e.g., listed as threatened or endangered) or species proposed for listing, or (2) could result in the destruction or adverse modification of critical or proposed critical habitat. The USFWS provided upon request a list of species that must be considered for this EIS.

The Council of Environmental Quality Regulations for Implementing the National Environmental Policy Act (Section 1508.27) also requires considering if an action may violate federal, state, or local laws or requirements imposed for the protection of the environment. For this reason, species listed under the California Endangered Species Act (i.e., those considered endangered or threatened) by the California Department of Fish and Game are included in this analysis. Species proposed for listing in either of the two categories are also included.

NPS Management Policies (NPS, 2000) state: "The National Park Service will identify and promote the conservation of all federally listed threatened, endangered, or candidate species within park boundaries and their critical habitats.... The National Park Service also will identify all state and locally listed threatened, endangered, rare, declining, sensitive, or candidate species that are native to and present in the parks, and their critical habitats.... All management actions for protection and perpetuation of special status species will be determined through the park's resource management plan."

Additionally, park managers are to ensure that park operations do not adversely impact endangered, threatened, candidate, or sensitive species and their critical habitats, within or

outside the park and must consider federal and state listed species and other special-status species in all plans and NEPA documents (NPS-77 Natural Resource Management Guidelines).

NPS-77 states: "The following legislation, policies, and agreements provide the authority for NPS policies on management of threatened and endangered species: the Endangered Species Act; state-specific endangered species acts; other state wildlife statutes or agreements pursuant to Section 6, ESA; the Migratory Bird Conservation Act; the Fish and Wildlife Coordination Act; the Wild and Scenic Rivers Act; the Marine Mammal Protection Act; the Bald and Golden Eagles Protection Act; the Wilderness Act; the Convention on International Trade in Endangered Species; and maritime and other international agreements."

The USFWS normally takes lead Departmental responsibility for coordinating and implementing provisions of the Endangered Species Act for all listed endangered, threatened, and candidate species, particularly for all terrestrial plants and animals and freshwater aquatic species. However, for certain listed taxa such as *Cetacea* (all whales and porpoises), most *Pinnipedia* (Steller sea lions, Hawaiian monk seals, etc.), sea turtles, and anadromous fish (steelhead, coho salmon, etc), the NOAA Fisheries plays a very active role under provisions of both the Endangered Species Act (1973) and the Marine Mammal Protection Act (1972). For those marine species including fish it is often a case of shared USFWS\NOAA Fisheries responsibilities, with NOAA FISHERIES frequently assuming the lead role. In each instance discussed below, where the listed species in question is a fish, whale or pinniped, the term "FWS" might more accurately read "NOAA FISHERIES" or "NOAA FISHERIES and FWS." This is particularly true for any activity that may involve the "taking" of a marine mammal of special status fish species such as threatened coho salmon and steelhead trout.

The federal, state, and CNPS categories for special-status species are defined as:

- Federal endangered: Any species that is in danger of extinction throughout all or a significant portion of its national range.

- Federal threatened: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its national range.

- California endangered: Any species that is in danger of extinction throughout all or a significant portion of its range in the state.

- California threatened: Any species that is likely to become an endangered species with the foreseeable future throughout all or a significant portion of its state range.

- California rare (plants only): A native plant that, although not currently threatened with extinction, is present in small numbers throughout its range, such that it may become endangered if its present environment worsens.

CNPS List 1A:	Presumed Extinct in California
CNPS List 1B:	Rare or Endangered in California and Elsewhere
CNPS List 2:	Rare or Endangered in California, More Common Elsewhere

CNPS List 3: Need More Information
CNPS List 4: Plants of Limited Distribution

Assessment Methodology

Special Status Plants
Fire plays a role in the life history of many special-status plant species by maintaining open habitat, encouraging reproduction, and affecting competing species. Fire may injure or kill individual plants while the effects on the species as a whole are beneficial because competition has been reduced or openings (i.e., habitat) created. Fire suppression activities can adversely affect these same species because of ground disturbance. Prescribed fires can be detrimental, especially when timing, frequency, and intensity of fire are outside of the natural fire cycle to which the species is adapted. Keeping these factors in mind, the following parameters have been used to evaluate the consequences of the various alternatives on special-status plants:

- The species affected and its degree of local, regional, national, and global rarity.
- The numbers of plants or proportion of the species range affected by the action.
- The response of the species to fire or disturbance (if known).

Type of Impact
Adverse: would lead to loss or alteration of habitat, loss of individuals or populations of special-status plants, or reduction in reproduction.

Beneficial: would lead to increases in suitable habitat, an increase in aerial extent or density of plants, or an increase in reproduction.

Duration of Impact
Short-term: would immediately affect the population or species, but would have no long-term effects to population trends or species viability.

Long-term: would lead to a loss in population or species viability - exhibited by a trend suggesting decline in overall species aerial extent or abundance.

Intensity of Impact
Negligible: Imperceptible or note measurable (undetectable).

Minor: Small, measurable, perceptible and localized, without the potential to increase if left alone.

Moderate: Apparent, measurable, and sufficient to cause a change in the resources (e.g., abundance, distribution, quantity, or quality). Less localized than a minor impact.

Major: Substantial, highly noticeable, and with the potential for landscape-scale effects and major irreversible population effects.

Special Status Wildlife (including fish and other aquatic species)
Like other wildlife species in the project area, special-status species have adapted to natural fire regimes. In many areas, however, a history of fire suppression has led to dense, overgrown stands, with high accumulations of forest fuels. This affects special-status species by altering habitat and placing these species and their habitats at risk of high-intensity, stand-replacement fire. In addition, stand-replacement fire could create unsuitable habitat conditions that would last for many years.

Fire control activities could also adversely affect special-status species through direct disturbance of animals and habitats. Even management actions designed to benefit habitat, such as prescribed fire, can have inadvertent adverse effects on special-status species. With these factors in mind, the following parameters have been used to evaluate the effects on special-status animals of the various alternatives:

- The species affected and its degree of local, regional, nationally and global rarity.
- The rarity of the genotype or subspecies, regionally, nationally, or globally.
- The numbers of animals or proportion of the species range affected by the action.
- The response of the species to fire or disturbance (if known), on a population or sub-population level.

Type of Impact

Adverse: Likely to result in unnatural changes in the abundance or distribution of a special-status species. This could occur through direct disturbance, mortality, or through destruction or alteration of habitat.

Beneficial: Likely to protect and/or restore the natural abundance and distribution of a special-status species. This could occur through protection and restoration of structure, successional state, or distribution of habitat.

Duration of Impact

Short-term: would result in immediate changes in the abundance and distribution of a special-status species, but a return to the original condition occurs within two generations of that species.

Long-term: would result in changes in the abundance and distribution of a special status species that persist for greater than two generations of that species.

Intensity of Impact

Negligible: would be imperceptible or unmeasurable (undetectable).

Minor: would be slightly perceptible and localized in extent; without further actions, adverse impacts would reverse and the resource would recover.

Moderate: would be readily measurable (apparent) and extend further geographically than a minor impact, adverse impacts would eventually reverse and the resource would recover.

Major: would be substantial, highly noticeable, and affecting a large geographic area; changes would be irreversible with or without active management.

Cultural Resources

Policies and Regulations
Fire management actions such as prescribed fire, suppression, and mechanical treatments have the potential to impact cultural resources such as archeological sites, structures, ethnographic resources, and cultural landscapes. Museum objects can also be threatened by such actions, both the physical well being of the objects themselves, and the ability to properly catalog and process those objects.

Section 106 of the National Historic Preservation Act requires Federal agencies to consider the effects of its actions on properties listed in, or eligible for inclusion in, the National Register of Historic Places (i.e., Historic Properties), and allow the Advisory Council on Historic Preservation a reasonable opportunity to comment. Proper management of museum objects is dictated by 36 CFR 79.

Presently the agencies comprising the DOI, including the National Park Service and the U.S. Department of Agriculture, are developing a nationwide Programmatic Agreement with each state's respective Historic Preservation Office, the National Council of State Historic Preservation Offices, and Advisory Council on Historic Preservation. This document will follow procedures outlined in 36 CFR 800.14(b) of Section 106 of the National Historic Preservation Act. Among the core elements of the Programmatic Agreement include professional qualifications, standard protocols for cultural resources compliance for fire management actions, Indian Tribe and public participation, agency review procedures, and inadvertent effects. The benefit of Programmatic Agreement will be greatly expedited Section 106 compliance review for fire management actions, as well as the establishment of standard protocols for most effectively identifying, evaluating, and protecting cultural resources during planned and unplanned fire management actions.

Terms found in Section 106 of the National Historic Preservation Act are used to describe cultural resource significance and effects in this section. However, it is important to distinguish Historic Properties (as defined above) from resources of interest, which are those classes of resources that have some potential to be important, and have the potential to be impaired by the fire management action. While Historic Properties are de facto resources of interest, these might also include sites, features, structures, or other phenomenon that do not meet National Register of Historic Places criteria of significance, the minimum age requirement, and/or possesses sufficient integrity, but contribute somehow to our understanding of prehistory, history, or traditional lifeways, and could be compromised. Each resource of interest is comprised of a set of attributes, called significant characteristics, which lend importance to that resource.

Cultural Resource Impacts Defined
NEPA recognizes three types of impacts - direct, indirect, and cumulative. Direct impacts are those that are caused at the same time and place as the action, indirect impacts occur later in time

and at a distance, while cumulative impacts are additive. In regard to cultural resources, direct, operational, and indirect effect categories are utilized. Direct effects are those where the fire itself is the cause of the impacts, operational effects occur as a result of associated operations like line construction or staging, while indirect effects are ones where fire and/or associated operations result in changes to local context such that cultural resources would be affected. As such, direct and operational effects for cultural resources are the equivalent of direct impacts under NEPA, while indirect effects on cultural resources correspond to indirect and cumulative impacts.

NEPA also dictates that potential impacts are considered in regard to type (adverse, beneficial) duration (short-term, long-term, permanent), and intensity. The Section 106 process considers only the adverse effects upon cultural resources, not potentially beneficial ones. An ordinal scale of impact intensity (negligible, minor, moderate, major) is also foreign to the Section 106 process - effects are either adverse (when the integrity of the historic property is diminished due to the undertaking) or they are not. Duration is not typically factored when assessing effects during the Section 106 process. These issues are considered in greater detail below in relation to direct, operational and indirect effects.

Assessment Methodology

Archeological research ranging from site survey to complex archeological excavations has taken place primarily from the early 1900s through the present. Thirty-two archeological sites on the Point Reyes peninsula were partially excavated from the 1940s through the 1960s by archeologists from the University of California at Berkeley, San Francisco State University, Santa Rosa Junior College, and the Drake Navigators Guild. Information gained from these excavations was critical in placing the Coast Miwok culture within local and regional chronologies and in gathering evidence of early Coast Miwok contacts with Drake and Cermeno.

The following measures are employed to assess impacts of fire management actions on cultural resources. Further rationale for each measure is provided in discussions of direct, operational, and indirect effects that follow.

Type of Impact

Adverse: Changes to the significant characteristics of a resource of interest. These changes may be perceptible and measurable, or, in the case of certain archeological and ethnographic resources, imperceptible, and psychological.

Beneficial: Changes on or in the vicinity of a resource of interest such that the significant characteristics of the resource are protected against adverse impacts of fire management actions and/or restored to some desired condition.

Duration of Impact

Archeological Resources

Short-term Adverse: Changes that result in permanent or temporary loss of data potential in the significant characteristics of a resource of interest, but do not manifest for a period of 10 or fewer years following the fire management action.

Short-term Beneficial: Changes that afford protection to the significant characteristics of a resource of interest from fire management actions for a period of no more than 10 years.

Long-term Adverse: Changes that result in a permanent or temporary loss of data potential in the significant characteristics of a resource of interest, and manifest in more than 10 years following the fire management action.

Long-term Beneficial: Changes that afford protection to the significant characteristics of a resource of interest from fire management actions for a period of no more than 10 to 20 years.

Permanent Adverse: Changes that result in permanent loss of data potential in the significant characteristics of a resource of interest, and manifest immediately following the fire management action.

Permanent Beneficial: Changes that result in permanent protection to the significant characteristics of a resource of interest from fire management actions.

Structures

Short-term Adverse: Changes that result in a permanent or temporary loss of data potential in a resource of interest, but do not manifest for a period of 10 or fewer years following the fire management action.

Short-term Beneficial: Changes that afford protection to the significant characteristics of a resource of interest from fire management actions for a period of no more than 10 years.

Long-term Adverse: Changes that result in a permanent or temporary loss of data potential in a resource of interest, and are manifest in more than 10 years following the fire management action.

Long-term Beneficial: Changes that afford protection to the significant characteristics of a resource of interest from fire management actions for a period of no more than 10 to 20 years.

Permanent Adverse: Changes that result in permanent loss of data potential in a resource of interest, and that are manifest immediately following the fire management action.

Permanent Beneficial: Changes that result in permanent protection to the significant characteristics of a resource of interest from fire management actions.

Cultural Landscapes

Short-term Adverse: Temporary alteration of the significant characteristics of a resource of interest for a period lasting no more than 10 years. Short-term alterations will almost always involve living vegetation.

Short-term Beneficial: Temporary protection, restoration, or maintenance of the significant characteristics of a resource of interest for a period lasting no more than 10 years.

Long-term Adverse: Temporary alteration of the significant characteristics of a resource of interest for a period lasting more than 10 years. Short-term alterations will almost always involve living vegetation.

Long-term Beneficial: Temporary protection, restoration, or maintenance of the significant characteristics of a resource of interest for a period lasting more than 10 years.

Permanent Adverse: Permanent alteration of the significant characteristics of a resource of interest. Permanent alterations will often encompass both living vegetation and other landscape features.

Permanent Beneficial: Permanent protection, restoration, or maintenance of the significant characteristics of a resource of interest.

Intensity of Impact

In this analysis, intensity of impact is measured relative only to adverse resource impacts.

Archeological Resources

Negligible: No or barely perceptible and changes to the significant characteristics of a resource of interest.

Minor: Perceptible and measurable changes to the significant characteristics of a resource of interest, but those changes do not inhibit interpretive potential and/or a minor percentage of the significant characteristics would be affected. Resources prone to impacts in this category might include archeological resources containing a high percentage of resources of interest with low vulnerability to the effects of fire management actions and/or possessing subsurface components.

Moderate: Perceptible and measurable changes to the significant characteristics of a resource of interest, but those changes do not inhibit interpretive potential and/or a moderate percentage of the significant characteristics would be affected. Resources prone to impacts in this category might include archeological sites containing a moderate percentage of resources of interest with low vulnerability to the effects of fire management actions and/or possessing subsurface components.

Major: Perceptible changes to the significant characteristics of a resource of interest, and those changes inhibit interpretive potential of a major percentage of the significant characteristics. Resources prone to impacts in this category might include archeological sites containing a large percentage of resources of interest with high vulnerability to the effects of fire management actions.

Structures

Negligible: Barely perceptible and not measurable changes confined to a single resource of interest or contributing element of a larger National Register district. Changes do not adversely affect significant characteristics.

Minor: Perceptible and measurable changes to a single resource of interest or contributing element of a larger National Register district. Changes do not adversely affect significant characteristics.

Moderate: Perceptible and measurable changes in the significant characteristics of a single resource of interest or small group of contributing elements in a larger National Register district.

Major: Perceptible and measurable changes of substantial magnitude in significant characteristics of a single resource of interest or large group of contributing elements in a National Register district.

Cultural Landscapes

Negligible: Barely perceptible and not measurable changes to a resource of interest.

Minor: Perceptible and measurable minor changes to a resource of interest. For example, a severe wildfire kills a highly visible concentration of non-contributing oak trees located on the boundary of a rural historic cultural landscape.

Moderate: Perceptible and measurable moderate changes in the significant characteristics of a resource of interest. For example, a fire crew cuts down several contributing fruit trees in a rural historic cultural landscape in preparation for a prescribed burn.

Major: Perceptible and measurable changes of substantial magnitude in significant characteristics of a resource of interest. For example, extreme fire behavior and aggressive suppression action destroys a large number of contributing elements within a rural historic cultural landscape.

Visitor Use and Visitor Experience

Policies and Regulations

NPS Management Policies 2001 makes numerous references to aspects of aesthetics as central issues in the considerations that go into resource management. It includes, under the natural

resources and values that the NPS must protect, "aesthetic values, such as scenic vistas, natural quiet, and clear night skies."

Scenic resources are extremely sensitive to air pollution. Even a very small amount of fine particulate matter (less than 2.5 microns in diameter or one tenth the diameter of a human hair) in the air can affect the ability to perceive colors, contrast, texture, and form of features, landmarks, and panoramas. Visual air quality is very important to park visitors. Specific vistas are often mentioned in legislation or Congressional reports concerning the establishment of an NPS unit. Visibility in mandatory class I areas is also specifically protected by the Clean Air Act (Director's Order-77: Natural Resource Management Guidelines).

This Director's Order #47 addresses the problem of excessive/ inappropriate levels of noise. It directs park managers to (1) measure baseline acoustic conditions, (2) determine which existing or proposed human-made sounds are consistent with park purposes, (3) set acoustic management goals and objectives based on those purposes, and (4) determine which noise sources are impacting the park and need to be addressed by management. Furthermore, it requires park managers to (1) evaluate and address self-generated noise, and (2) constructively engage with those responsible for other noise sources that impact parks to explore what can be done to better protect parks.

Assessment Methodology

The effects of each alternative were evaluated by analyzing potential impacts on the physical component of the landscape and how the change may be experienced using best professional judgment. The following aspects of actions within the alternatives were assessed as directed by NPS-77:

> Could the action or activity be seen from the park? From a developed overlook, road, or trail? Would the action or activity be continuously or intermittently seen? Are there any alternative sites that are less visible or not visible from the park?
>
> Could the action impact a scenic vista along a road or a scenic view? How long would the fire management treatment impact an area?
>
> Could the action or activity be heard in the park? Where in the park would the sound be most noticeable or intrusive? From developed overlooks, headquarters areas, or trails? Would the sounds be continuous or intermittent? Are there any ways in which the effects of the sound could be mitigated or lessened?

As these questions indicate, systematically looking at the effects of proposed activities or actions aims at evaluating what may be lost, rather than what has been generally thought to describe the existing resource condition. For example, routine baseline monitoring of natural resources would not ordinarily take into account the degree of quiet that characterizes a park or the clarity of night sky, but these are precisely the kinds of issues that come under the framework of aesthetics.

Aesthetic considerations can be quantitatively monitored. It is possible to map viewsheds and photograph visibility. Air quality and weather data can provide limited modeling for visibility and odor concerns. Various characteristics of natural- and human-caused sounds can also be measured.

Unfortunately, there is no objective, numerical standard or threshold that can be employed to state what constitutes an aesthetic effect. As is often the case in NPS management, judgment is necessary. Effects on aesthetics also should be analyzed in the context of cumulative effects of a number of different activities or actions, both within and outside parks. What could be insignificant alone (for example, one helicopter trip near a popular overlook) could become significant in the context of other activities or actions (one helicopter trip in combination with nine diesel buses and a nearby, audible, and visible clearcutting operation).

It is often the case that frequency or duration of an activity or action causes it to be transformed from being acceptable in the park or its vicinity, in aesthetic terms, to being unacceptable. For example, scenic overflights were considered to be acceptable over the Grand Canyon until the numbers and duration of the flights caused a deterioration of the aesthetic experience for other park visitors. Limitations on backcountry use may be based, in part, on the potential for adverse effects on visitor aesthetic experience from too many other users. Sociological studies can be useful to evaluate visitor preferences and aesthetic effects.

Visitor experience is also directly affected by actions influencing natural resources such as air quality, scenic resources, and cultural resources. Though impacts to these resources are not considered again in this analysis of visitor experience, enhancement, or degradation of these resources also enhances or degrades the quality of the visitor experience.

Impacts on visitor experience and visual quality have been assessed using professional judgment to develop a qualitative analysis of the effects of actions on the activities of park visitors. These conclusions have been considered in combination with data on the proportion, when known, of visitors who participate in different activities while in the park.

Type of Impact

Beneficial: would enhance visitor participation, quality of visitor experience, service level, or the visual quality of the landscape.

Adverse: would reduce visitor participation, or degrade the quality of visitor experience, service level, or the visual quality of the landscape.

Duration of Impact

Short-term: would be temporary (less than 90 days) and due to fire management activities such as prescribed burns or mechanical clearing of vegetation.

Long-term: would be permanent and/or continuous.

Intensity of Impact

Negligible: would result in little or no noticeable change in visitor experience.

Minor: would be detectable but localized within a relatively small area (less than 250 acres in one area); would result in changes in visitor experience but would not appreciably limit or enhance critical characteristics.

Moderate: would be highly noticeable, and/or change the visual character of the landscape in areas larger than 500 acres, but affected areas would be located away from heavily used roads or trails; would change the desired visitor experience appreciably, (i.e., changes one or more critical characteristics, or appreciably reduces/increases number of participants).

Major: would be highly noticeable, and/or change the character of the landscape in areas larger than 1000 acres, and affected areas would be visible from heavily used roads or trails; would eliminate or greatly enhance multiple critical characteristics or greatly reduce or increase participation.

Park Operations

Policies and Regulations

Congress established the National Park Service (NPS) in 1916. To fulfill its mission, the NPS receives funding from both the federal appropriations process and other federal revenue sources.

Like most federal agencies, the NPS relies on Federal appropriations to fund its core activities, although there is increasing use of alternative revenue sources, such as fees, to supplement operations. The NPS requests direct Congressional funding and reports on the other federal revenue sources through an annual budget document submitted to Congress entitled "Budget Justifications," or more popularly called, the "Green Book."

Financial resources currently available to PRNS include a base-operating budget of approximately $4,949,000, which represents about 115 FTE (full time equivalents or one person for a full year). This work force would be supplemented by 20,000 hours of Volunteers-in-Parks service, 2-4 Student Conservation Assistants, and AmeriCorps volunteer work groups and special project and program funds distributed by the National Park Service regional and Washington offices.

In addition to the above operational funding, the park receives fee revenues and special national park funding for specific maintenance and other projects. For example, the park is expected to receive about $1.6 million in this one-time funding this year for cyclic maintenance on historic structures and other natural resources projects. As part of the San Francisco Bay Network, the National Seashore will have access to approximately $900,000 for natural resource challenge inventory and monitoring funds. Also, the park will receive about $625,000 in fee revenues for other maintenance projects and operation of the whale shuttle system and campground reservation system. In addition, the park receives approximately $1,000,000 in FirePro and Wildland Interface funding for hazardous fuel reduction and fire prevention activities.

Assessment Methodology
Impacts were evaluated by assessing changes that would be required to meet the operational requirements outlined in each of the alternatives. Relative costs were generated, using staff estimates of funding and labor required to implement these actions. These effects were compared to existing operations, staffing, and funding at the Seashore.

Existing staffing levels were inventoried and assessments were made of current park operations. In addition, professional judgments by individuals who are most knowledgeable about various activities were used to anticipate the operational changes that would be needed under each action alternative. Estimates were made of the personnel required to:

- provide education and information services to the public regarding fire activities;
- conduct mechanical treatments to reduce hazardous fuels; and
- conduct prescribed fires to preserve natural and cultural resources and reduce hazardous fuels.

These assessments were compared to existing staffing levels. It should also be noted that staffing and funding impacts for the action alternatives are difficult to project until final plans are completed. Thus, the estimates are intended to provide a general description of potential effects, considering the variability within the range of possible operational scenarios.

The discussions of impacts are for operations that would be new, undergo major change, or show susceptibility to increases or decreases in operational activity.

Type of Impact
Adverse: would represent an increase in operating costs.

Beneficial: would represent a decrease in operating costs.

Duration of Impact
Short-term: would last only until all actions are completed.

Long-term: would have a permanent effect on operations.

Intensity of Impact
Negligible: there would not be a measurable difference in costs from existing levels.

Minor: additions or reductions in cost would be less than 15% of existing levels.

Moderate: additions or reductions in cost would be between 16% and 30% of existing levels.

Major: additions or reductions in cost would be more than 30% of existing levels.

Public Health and Safety

Policies and Regulations

The health and safety of firefighters and the public is the highest priority in every action undertaken as it relates to firefighting strategy and tactics. Director's Order #18 states, "…firefighter and public safety must be the first priority in all fire management activities." National Park Service Management Policies states "all wildland fires would be effectively managed, considering resource values to be protected and firefighter and public safety…." All actions taken involving wildland fire have as their overriding goal providing for firefighter and public safety.

Assessment Methodology

Fire management activities and the potential for injury, illness, and other direct and indirect impacts are evaluated for their potential to affect public and fire personnel during fire management activities at Point Reyes National Seashore. The analysis includes the impacts of prescribed fire, suppression, wildland fire use and mechanical treatment on the health and safety of the public and fire personnel.

Type of Impact

Beneficial: would result in a reduction in human health and safety concerns; or would improve human health or safety.

Adverse: would result in additional or exacerbated public health and safety concerns.

Duration of Impact

Long-term: would have a permanent effect on human health and safety (i.e., contamination of a water source for domestic use would be a long-term impact).

Short-term: would be temporary (less than one month) and would be associated with transitional types of impacts (e.g., safety concerns related to smoke from a prescribed burn).

Intensity of Impact

Negligible: Imperceptible or undetectable effect upon public or fire personnel.

Minor: Minor impacts would be slightly detectable or localized, upon public or fire personnel within a portion of the body.

Moderate: Moderate impacts would be those that are readily apparent but that would not result in limits on activities. Would be clearly detectable and could have an appreciable effect on public health and safety (i.e., introduction of noise, public health hazards or safety hazards).

Major: Major impacts would be substantial, highly noticeable impacts and/or impacts that would result in limits on activities. Would be clearly introducing a significant public health hazard such as the introduction of significant air or water pollution.

Socioeconomics

Policies and Regulations

The NPS regulations for NEPA say "social and economic impacts are considered an integral part of the human environment in the NPS and should be analyzed in any NEPA document where they are affected. Socioeconomic impacts include those to minority and low-income communities as specified in the Environmental Justice Executive Order (EO 12898; Feb. 11, 1994)." This executive order - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations - requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities.

Assessment Methodology

In addition to any possible effects on minority and low-income populations and communities, alternatives were evaluated for their potential direct impacts, such as property loss, and indirect economic effects, such as from park closures.

Type of Impact

Adverse: Degrades or otherwise negatively alters the characteristics of the existing environment, as it relates to local communities including minority and low-income, visitor population, regional economies, and concessioners and contractors.

Beneficial: Improves on characteristics of the existing social and economic environment, as it relates to local communities including minority and low-income, visitor population, regional economies, and concessioners and contractors.

Duration of Impact

Short-term: Temporary and typically transitional; associated with implementation of an action.

Long-term: Permanent impacts on the social and economic environments.

Intensity of Impact

Negligible: Undetectable and expected to have no discernible effect on the social and economic environment.

Minor: Slightly detectable and not expected to have an overall effect on the character of the social and economic environment.

Moderate: Detectable and could have the potential to initiate an increasing influence on the social and economic environment.

Major: Substantial, highly noticeable influences on the social and economic environments, and could be expected to alter those environments permanently.

The action alternatives are anticipated to slightly increase annual air pollutant emissions but lower the potential for a large, uncontrolled wildfire with excessive emissions of air pollutants. It is anticipated that after a transition period, natural fire ecology would be closer to pre-suppression return intervals, and the risk of large, catastrophic fires would gradually decline.

IMPACT ANALYSIS

IMPACTS TO SOILS

Alternative A
The actions associated with Alternative A could affect soil resources within the Estero, Limantour Road, Highway One, and Bolinas Ridge FMUs (prescribed fire only).

Types of Impacts
The types of impacts soils can experience from burning are varied, and can include changes to its physical, biological, and chemical properties. The degree of effect on soil is related in large part to the intensity of a fire, although this can change with the property of the soil when a burn takes place as well. Because the types of effects are the same, they are discussed together in this introductory section. The degree of impact, as well as other specific information, is then broken out in the sections on the impacts of prescribed fire and wildland fire.

Soil characteristics
As noted above, the features of soils help in determining the degree of effect of a prescribed burn or wildland fire. Features include biological characteristics, such as the type of vegetation soils support; physical characteristics, such as soil moisture; and chemical characteristics, or soil composition.

Vegetation and Organic Matter. High heat intensities from slow moving fires in heavy fuels can detrimentally affect physical, biological, and chemical properties of soil to varying degrees. Grass fires typically burn quickly over an area and cause little or no soil heating. For example, grassland thatch one centimeter high can serve to insulate soils from heating as a low intensity, fast moving, fire most common in grassland, burns quickly across the top of the litter. Less litter and ground cover can therefore result in greater effects on soil resources. Even the heat generated by heavier fuels involved in chaparral fires in southern California was found to be largely restricted to the surface soil layer and damage to soils was limited (DeBano, et al., 1998). Severe fires can result when humus and large fuels are dry and near the ground conducting much heat into the soil from slow, smoldering fires; recovery in areas that supported heavy dry surface fuels may take years (McNabb and Swanson, 1990; Stanturf, 2002; Christensen, 1994).

Soil Moisture. Under similar fire conditions, dry surface soils will rise to higher temperatures and experience higher impacts than moist surface soils. In the project area, dry surface soils would be more common during wildfire season and moist surface soils common in the seasons

when most prescribed burns are conducted. Subsurface saturated soils can actually slow the diffusion of heat and protect underlying soils as heat will be poorly transmitted until moisture in the soil evaporates (Stanturf, 2002).

Soil Type. Granitic soils, such as those found in the Tomales Point and Inverness Ridge FMUs (having Kehoe Variant and Sheridan Variant soils) conduct heat faster than clay-rich soils or soils with a high organic content (Agee, 1993). In the project area, these granitic soils also support some of the more fire dependent plant communities, such as Bishop pine and Marin manzanita. The granitic soils and the overlying vegetation type are thought to contribute to post-fire hydrophobicity.

Range of Effects

The characteristics of soil are important in determining effects, but fires can change the factors described above, as well as other physical, chemical, and biological processes operating in soils. For example, high intensity, slow-moving burns kill soil biota, alter soil structure, consume litter and humus above ground and organic matter within soils, change the rate of water infiltration, reduce the ability of soil to retain water, vaporize important nutrients such as nitrogen and sulfur, and increase erosion of productive top soils (Robichaud, 2000b; Pyne, et.al., 1996; Christensen, 1994).

Erosion. The most common effect on soils is erosion by water, wind, or gravity following the removal of overlying vegetation by fire, whether it is prescribed or wild. The severity and duration of the accelerated erosion depend on several factors, including soil texture, slope, recovery time of protective cover, the amount of residual litter and duff, and post-burn precipitation intensity (Clark, 2001). Erosion selectively removes nutrients, organic materials and fine particles from topsoil reducing soil productivity. A decrease in productivity can have a consequent effect on the density, vigor and range of plant species that will survive or repopulate an area. Reduced productivity may also allow for the establishment or expansion of populations of opportunistic invasive exotic plant species that thrive in poor soils. On a larger scale, the transportation of soils through erosion can result in changes to the landscape such as the formation of gullies or the sedimentation of ponds and wetlands and clogging of stream channels.

The soils with the highest potential for erosion are on the steepest slopes – greater than 50% - along the top of Inverness Ridge. This area primarily supports forests, where replacement of vegetation cover is normally slow in comparison to grasslands or shrublands. De Bano and others (1996) specifically monitoring rates of erosion following a wildfire in ponderosa pine, found sediment yields from a low severity fire recovered to normal levels after 3 years, but moderate and severely burned watersheds took 7 and 14 years, respectively. Areas of the Vision Fire supporting fire dependent species, such as Bishop pine and Marin manzanita, as well as sandy loam soils supporting hardwoods and riparian vegetation appeared to have largely recovered effective soil cover by the second winter following the fire but long-term investigation into recovery of surface soil properties was not conducted.

Hydrophobicity. Hydrophobicity can result when fire increases soil temperatures causing the volatilization of hydrophobic materials into the soil. It is thought that the hydrophobic materials

may be deposited by certain plants or are by products of decay (Christensen, 1994). The phenomenon has been highly reported following chaparral fires in Southern California where the gases that result from combustion move downward in the soil as vapors until condensing when cooler soils are encountered forming a nonwettable layer (Pyne et al., 1996). Some soils in the park may be particularly vulnerable to developing deep water repellent layers of soils. These include granitic soils or soils formed from coarse-grained sandstone (such as Kehoe Variant and Sheridan Variant soils) with heavy fuel loads, such as shrubs or trees (Oster, 2003). Granitic soils with a grass cover experience low intensity burns and develop little hydrophobicity. In a hot wildfire, these layers can be quite deep. Following the Vision Fire, erosion and channel cutting was observed in areas of granitic soils cleared of overlying vegetation and exhibiting hydrophobicity from 2 to 8 inches in depth (Collins and Ketcham, 2001). However, the impermeable layer that develops in the upper soil horizon may have beneficial impacts by controlling the loss of moisture to evaporation. This maintains soil moisture and encourages seedling establishment (Clark, 2001). Such a positive impact was observed following the Vision Fire, as by year two, only small areas of hydrophobicity remained having been broken up by the action of sprouting vegetation, decay of organic oils on the soil surface and rilling.

Slope Failures. In addition to increasing erosion, hydrophobicity can also be associated with fire-associated slope failures (DeBano et al., 1998). This happens when the accelerated runoff flowing downslope is circumvented by natural preferential flow-paths within the soil resulting from soil cracks or root channels. When heavy rains occur in areas with susceptible soils, the layer between the surface and the hydrophobic layer can become saturated (Pyne et al., 1996). After a high intensity fire, when roots have burned or are decaying, runoff finds the vertical tunnels left by the roots and moves quickly on these macropore routes causing localized saturation and increasing the potential for landslides and debris flows.

Nutrient Loss and Deposition. Fires can release important plant nutrients, such as phosphate, sulfate and nitrogen, as organic matter is volatilized through combustion both into the air and forced down into the soil (Pyne et al., 1996). Conversely, ash deposits from the fires themselves can increase the amount of nutrients available to plants post-fire, especially nitrogen, and can spur rapid plant growth following the fire. Where rains quickly follow a wildland or prescribed burn, much of the beneficial ash layer can be lost to stormwater runoff. Nutrients are replaced in part by rainfall, dust, pollen, decomposition of downed material, and growth of nitrogen-fixing plants such as *Lupinus*, *Lotus*, *Alnus* (Alder) and *Ceanothus* (DeBano, 1998; Agee, 1993).

Post-fire Increase in Soil Temperature. Fires that consume most understory vegetation, reduce canopy cover, and and/or leave a deposit of dark ash can also lead to a subsequent increase in soil temperature from increased absorption and exposure to the sunlight. Under similar moisture regimes, warmer soils increase the rate of decomposition, and nutrient availability to post-fire vegetation and may increase microbial activity and rates of decomposition (Clark, 2001; Christensen, 1994).

Loss of Organic Matter. One of the most noticeable effects of fire on soil is the combustion of organic matter, both on the soil as litter and buried within the soil. Organic matter helps regulate the hydrologic cycle and the carbon/nitrogen ratio, provides a site for nitrogen fixation by N-fixing bacteria, and maintains soil structure porosity and the cation exchange capacity. In Marin

soils, the percent of organic matter in the surface mineral layer varies from less than one percent up to ten percent. The Reyes and Sheridan Variant soils have the highest percent organic matter in the duff or surface mineral layer. Other soils with high level of organic matter include Centissima, Dipsea, Maymen, Maymen Variant, McMullin, Palomarin, and Wittenberg soils (Oster, 2003).

Loss of Beneficial Organisms. A small percentage of combustion energy is expended in radiating downward during a fire causing higher temperatures in the upper soil layers. In a hot fire, beneficial fungi and bacteria that live in the soil can be destroyed, and subsurface dwelling wildlife, such as tunneling rodents, can be killed. Populations of microfauna and microflora typically decline following a severe fire but the increase in available nitrogen spurs plant growth which in turn fosters the reestablishment of the soil microorganisms. Often high intensity fires can serve to sanitize soils of pathogens over the short-term and may locally improve soil productivity (Pyne et al., 1996). Prescribed fire may reduce or increase plant pathogens found close to the surface. An increase in populations of Trichoderma, a soil fungus, was found by sampling a ponderosa pine forest following a prescribed burn (Reaves, 1990). Through laboratory analysis, it was determined that these fungi inhibited the growth of Armillaria ostoyae, responsible for serious root diseases in coniferous forests and plantations.

Analysis

Prescribed fire

Prescribed fires generally burn at lower intensities than wildland fires and have fewer associated effects on soil resources. In the project area, prescribed burns are typically scheduled for the fall, winter, or spring - seasons which provide the environmental conditions that fit into the parameters (sufficient fuel moisture, low ambient temperatures, low wind speed, etc.) required to conduct a prescribed burn. The same parameters that permit implementation of prescribed burns also tend to reduce the intensity of a spreading fire, reducing the severity of effects on soil resources. Research has found that, in addition to negative effects, low intensity fire occasionally had beneficial effects on soil, often had no measurable effect and, further, the negative effects often were short-lived (Clark, 2001; Stanturf et al., 2002). These negative effects are primarily erosion and changes in the soil itself, and are described in more detail below.

Erosion. As noted above, the severity and duration of the accelerated erosion depend on several factors, among them, slope, soil type, and the recovery time of protective cover (Clark, 2001). Prescribed burns in the project area would be conducted primarily in moderately sloped grasslands and shrubs and in forested areas to reduce understory growth. These low intensity fires do not fully combust overlying vegetation, duff, and litter; and resultant erosion is limited largely to small patches, even on slopes (Stanturf, 2002). A research project that monitored the post-fire effects following a low intensity prescribed burn over a three-year period found no noticeable increase in either erosion or surface runoff in the burn area (Biswell, 1989, p. 151). Generally, it is thought that slopes that are currently stable would show little increase in erosion after a fire, whereas steeper slopes with soils that currently are subject to erosion would experience accelerated erosion post-fire (Pyne, 1996).

Three of the four FMUs where actions would occur under Alternative A contain areas where soils have a very high erosion potential based on the Natural Resources Conservation Service Erosion Hazard Rating (EHR). Erosion rating indicates that these soils have a very high potential of eroding if disturbed – whether by mechanical means or a natural event. The soils support primarily forests of Douglas-fir, Bishop pine, or redwood and, having slopes ranging from 50% to 75%, are some of the steepest areas in the project site. Roughly one-fifth of the total acreage of the Limantour, Highway One, and Bolinas Ridge FMU contain these soils.

A prescribed burn conducted in the forested areas of the FMUs would target reduction of understory fuels, and although burned areas may experience negligible or minor short-term soil loss until vegetation returns, it is likely areas would be readily revegetated under the near ideal climatic conditions at the Seashore if the burn intensity is low. Prescribed burning would have a relative positive impact on soils by re-introducing more natural fire intervals and intensities to an ecosystem where they have been suppressed. This and the reduction of fuel loading can have an important impact in reducing the potential for more damaging high intensity wildland fires to occur.

Erosion may also occur as a result of the formation of hydrophobic soils. As noted above, this phenomenon can be quite short lasting, even following high intensity wildfires such as the Vision Fire. Because the degree to which hydrophobic soils form is related largely to the intensity of the fire, prescribed burns would result in less severe formation of these water repellent soils for an even shorter period of time (Robichaud, 2000b; De Bano, et al., 1998).

The degree of impact to soils from erosion as a result of prescribed burning would never exceed minor, as defined in the Methodology section for soils. This means fewer than 10% of soils in any given watershed would be affected each year by prescribed burning activities. To ensure no greater than minor impacts, the park would continue its current practice of writing and approving burn plans.

To assure that attention is also given to the protection of soil resources, mitigation measures require that burn plans and associated erosion control plans prepared by the NPS be reviewed by a subject matter expert, such as a hydrologist or erosion specialist, prior to approval for implementation. The subject matter expert would determine whether the erosion control plan submitted is sufficient to prevent long-term moderate or major impacts on the rate of soil erosion. In other words, the expert would determine whether the proposed erosion control strategy would be sufficient to ensure no greater than minor impacts to soils from erosion. If the assessment finds that standard erosion control strategies would be insufficient to avoid a long-term moderate or major effect on the rate of erosion, a separate environmental process would be initiated for that burn plan. Some of the strategies used to minimize impacts to soils are to avoid steep slopes, time burns to maximize favorable environmental conditions, and erosion control devices during burns.

Park fire management personnel focus prescribed burns on areas with gradual to moderate slopes, avoiding steeper areas and ridgetops where fire behavior is less predictive. In doing so, the areas with the more erosion prone soils (granitic soils on the ridgetops) are also avoided (K.

Riggs, pers.comm.). Any prescribed burn proposed for the forested areas would be designed to avoid the steeper slopes not only to reduce potential erosion but also to avoid losing control of the fire and placing firefighters and park and private resources at risk.

In addition to the steepness of the slope, the time it takes for a burn area to revegetate also influences the degree of erosion. In the project vicinity, the Seashore minimizes the time soil is exposed by conducting most prescribed burns in early fall just prior to the winter rains that result in quick revegetation. The park also leaves unburned strips of vegetation along riparian areas in its prescribed burns to reduce soil erosion in steeper slopes leading into drainages. Because prescribed fires are low intensity, they leave behind large woody debris and duff that act as barriers parallel to slopes and trap eroding soils.

Where existing roads and trails do not provide an adequate barrier to help contain a prescribed fire, fire lines are created with hand tools at the perimeter of the burn area. If not rehabilitated following the burn, the linear area cleared for the fire line could become a new drainage channel during heavy rains leading to accelerated soil erosion and a localized change in drainage patterns. The use of standard best management practices, such as the placement of erosion control blankets, sterile rice straw, contour felled logs, and material chipped on site to serve as mulch help to control impacts both during and following prescribed burns. Fire lines would also be scarified to promote revegetation and sufficient large woody debris left within the site to promote nutrient recycling.

The burn plan itself would be reviewed to make sure the yearly prescribed burning in any targeted watershed does not exceed 10% of the total acreage or otherwise have the potential to result in more than minor impacts to soil from erosion. This check would also ensure minimal impacts to water quality or aquatic wildlife. Alternative A would result in the prescribed burning of 500 acres or less, which, as Table 41 shows, is smaller than 10% of the acreage any of the watersheds proposed for treatment. Even if the annual plan for prescribed burning proposed work takes place in a single watershed, it would not be possible to exceed 10% of the acreage. Therefore, the effect of prescribed burning on 10% or less of the vegetation cover would normally be a negligible or minor short-term adverse effect. As noted above, if park review indicated that potential erosion would be greater than this even with the use of mitigation described above, additional environmental analysis would occur.

Table 41. Alternative A, Potential Watershed Level Effects

Watershed (Total Acreage)	Alternative A FMUs in each Watershed	Alt. A FMU acreage within this Watershed	% of Watershed within this FMU	Potential for Moderate or Major Impact on Watershed Soils
Bolinas Drainages Watershed (7,902 acres)	Bolinas Ridge	259 acres	3.3%	No. 10% of watershed = 790 acres which is > 500 acres (annual limit Alt. A).
	Highway One	521 acres	6.6%	
Drakes Bay Drainages Watershed (12,758 acres)	Limantour Road	820 acres	6.4%	No. 10% of watershed = 1,276 acres which is > 500 acres (annual limit Alt. A).

Watershed (Total Acreage)	Alternative A FMUs in each Watershed	Alt. A FMU acreage within this Watershed	% of Watershed within this FMU	Potential for Moderate or Major Impact on Watershed Soils
Drakes Estero Watershed (17,720 acres)	Estero Limantour Road	1636 acres 2543 acres	9.2% 14.3%	No. 10% of watershed = 1,772 acres which is > 500 acres (annual limit Alt. A).
Lagunitas Creek Watershed (53,161 acres)	Bolinas Ridge	1339 acres	2.5%	No. 10% of watershed = 5,316 acres which is > 500 acres (annual limit Alt. A).
Olema Creek Watershed (9,397 acres)`	Bolinas Ridge Highway One	606 acres 1347 acres	6.4% 14%	No. 10% of watershed = 940 acres which is > 500 acres (annual limit Alt. A).
Pine Gulch Creek Watershed (5,064 acres)	Bolinas Ridge Highway One	177 acres 1,012 acres	3.5% 14%	No. 10% of watershed = 506 acres which is > 500 acres (annual limit Alt. A).
Tomales Bay Watershed (29,218 acres)	Limantour Road	755 acres	2.6%	No. 10% of watershed = 2,922 acres which is > 500 acres (annual limit Alt. A).

Source: NPS GIS Database, 2003. Calculations are based on the total acreage within each FMP watershed and the total acreage of the FMUs sited either fully or partially within that watershed.

Changes in Soil Characteristics. Though usually more limited in effect than wildland fires, low intensity prescribed burns can result in changes to the upper few inches in the soil horizon (Christensen, 1994). As noted above, impacts can include the loss of nitrogen through combustion and volatilization and changes in subsurface biological activity. Offsetting these adverse impacts would be nitrogen deposited in fire ash and the function of large woody debris, which, when left within the perimeter of a burn promotes nutrient cycling and nutrient exchange between beneficial fungi and plant roots (DeBano, 1998). In addition, although the total amount of nitrogen and other nutrients available at a site may decrease after a fire, volatilization (producing an ammonium form of nitrogen), conversion to organic nitrogen by bacteria and nodules of legumes, such as ceanothus, and a reduction in competing vegetation (Pyne et al., 1996; Christensen, 1994) all act to increase the amount of nutrients readily available to remaining plants. Overall, the impacts of prescribed burning under Alternative A to soil productivity and chemistry would be adverse, short-term and negligible to minor in intensity.

Depending on temperatures reached in the upper few inches of soil, beneficial insects, bacteria, and fungi can be killed, and seeds and plant roots close to the surface can be damaged (DeBano, et al., 1998). Prescribed fire may also have indirect impacts by decreasing the number of soil organisms that hold others in check, ultimately resulting in an increase in what may be harmful pathogens. This was the case in a ponderosa pine forest following a prescribed burn (Reaves, 1990). Overall, Alternative A may result in negligible to minor short-term impacts on organisms in the soils and nutrients in the upper few inches of the soil horizons.

Unplanned Ignitions, Wildfire and Suppression

Wildland fire is both an anticipated element and a variable in the FMP. Wildland fire and the suppression and restoration actions that follow wildland fire all have the potential to affect park

soils. Wildland fire typically burns with a higher intensity than prescribed fire due to the dryer conditions of the fuels, higher ambient temperature and the potential for spread to more flammable types of vegetation and landscape conditions. Depending on the intensity and duration of a wildland fire, immediate and long-term changes in soil properties and processes can occur. Suppression activities may also have adverse impacts on soils. In the following section, impacts are described generally for wildfires, which are not expected to exceed 10-30 acres in an average year at the Seashore. These same types of impacts would occur, but be much more serious, in a catastrophic or large-scale wildfire, such as the 1995 Vision Fire. Because these are not part of the 10-15 year planning horizon for this plan, the impacts of catastrophic fire are analyzed throughout this EIS in the section on cumulative impacts.

High intensity, slow-moving wildland fires can effect numerous changes on the physical, chemical, and biological processes operating in soils. Severe burns can have all of the types of impacts described above in the introduction to this analysis and in the section of prescribed burns. The extent of the impact is likely to be more severe in the localized area of the burn, although the acreage burned through wildland fires in this alternative would on average be far less than 10% of that burned in prescription.

Erosion. High intensity wildland fires can remove nearly all of the protective vegetation covering soils, exposing soils to wind or water erosion. As noted above, erosion ultimately reduces soil productivity and vegetation. It can also create conditions under which exotic plant species are better competitors than native vegetation. Bare ground can remain bare for a longer period of time on steeper slopes, or when soils are susceptible to becoming hydrophobic. Clay rich soils subject to very high fire intensity may fuse at the soil surface, decreasing porosity, slowing infiltration of water, and increasing the rate of surface soil erosion. Rain can exacerbate erosion through the rilling of slopes and channel cutting, as well as through slope failure as described above for hydrophobic soils. However, it can also encourage rapid replenishment of organic matter though revegetation.

Changes in Soil Characteristics. A wildfire is likely to burn hotter than a prescribed burn, and can start in a wider variety of vegetation types and under drier conditions. As noted above, certain types of soils in the park are more vulnerable to become hydrophobic following a fire. A hot wildfire, such as may occur in forested areas of the park or where fuels have built up, may create hydrophobic soils deeper in these soils. In particular, granitic soils or soils formed from coarse-grained sandstone (such as Kehoe Variant and Sheridan Variant soils) which support forests of Bishop pine, tan oak, and a brush cover, could become water repellent with resulting erosion of top layers including through rilling, channel cutting and even slope failures. However, based on the short period of time soils remained hydrophobic following the Vision Fire, it is unlikely that the small acres burned by wildfire in a normal year would have more than negligible effects on soil through the formation of water repellent layers.

This is also true of plant nutrients that may be lost through volatilization during a fire. Organic matter on and in soil is also lost or changed through combustion. In a hot wildfire, the loss would be greater than in prescribed burn, as the effects would extend deeper into the soil and would not leave much organic matter on the surface. As noted above, hot fires may also kill beneficial fungi and bacteria that live in soils or wildlife that tunnel near the surface. Because the acreage

affected by wildfire is small, and because ash deposits can increase the amount of nutrients to plants following a fire, impacts to soil nitrogen, phosphate, sulfate, organic matter in soils, or biological microfauna or flora from wildfire in a typical year would not be more than negligible or minor.

Unlike prescribed burning, wildfires usually involve suppression activities, such as driving vehicles offroad to reach the site quickly. The weight of these vehicles compacts soils, increasing density and reducing pore size so that both water absorption and root growth are slowed and reduced. Clay and loam soils compact more readily and to a greater degree than sandy soils, and moist soils compact more easily than dry soils. Thick vegetation cover helps reduce potential soil compaction. Compacted areas may revegetate very slowly and tree recovery may take decades (McNabb and Swanson, 1990).

In addition to compaction, suppression activities can cause soil profile mixing, erosion, contamination, and overheating of soils. Manual or mechanized earthmoving to create firebreaks and roads or smother burning materials can mix the layers of the soil horizon, bury the fertile topsoil layer, and the native seedbed within the topsoil reducing the success of post-fire native plant revegetation. Uprooting trees and shrubs and scraping away covering vegetation during these actions expose soils to erosion by wind and water. Removal of covering vegetation and uprooting of plants and tree roots by heavy equipment exposes disturbed soils to erosion by water and wind.

In some cases, suppression activities can be responsible for the most intense impacts to soils. After the Oakland Hills fire, for example most erosion occurred as the result of ground disturbing activities from fire suppression (fire roads, firebreaks) and post-fire reconstruction. Because soil and soil productivity is slow to replace in human timescales, measures to prevent or minimize the impact of suppression are the most effective. Current practice has therefore shifted to limited scope projects that protect specific down-slope resources, such as areas of prior slope failure, water bodies, creeks and structures (Oster, 2003). For example, with the exception of response to a life threatening wildland fire, fire suppression vehicles or heavy equipment used for fire line construction should be directed away from stream channels, riparian areas, wetlands, sensitive biological areas, or perpendicular to slope contours. Park resource advisors working at the fire command center would provide the data and expertise to help fire command minimize impacts during suppression. Assuming these standardized mitigation measures and the small area of the park burned by wildfire each year, impacts to soils from suppression activities would be no more than negligible or minor.

Mechanical Treatments

Erosion. Mechanical clearing is performed by roadway mowing or by power tools. In most cases, plants are cut above ground leaving roots in place to prevent mixing the soil horizon, reduce erosion potential and stabilize slopes. Removal of large non-native trees, such as eucalyptus, often requires heavy equipment and could result in compaction of soils as trees are shifted to staging areas and hauled from the site by large trucks. Following the use of heavy equipment, all compacted areas should be scarified to encourage resprouting from the native seedbed. Standard erosion control strategies, such as erosion control blankets, should be

installed as required to prevent erosion. In most cases, these standard erosion control practices are effective in controlling erosion and reducing the effects of compaction that occur during mechanical treatment actions.

Changes in Soil Characteristics. In some instances, it is preferable to manage invasive non-native vegetation by removing the entire plant to prevent the resprouting of cut stalks and reduce the need for repeated treatments. When soils are saturated, plants such as French and Scotch broom pull out with little resistance causing little soil disturbance. This can results in a limited amount of soil horizon mixing as subsurface soils are pulled up with the plant roots. However, mechanical treatment actions rarely result in more than negligible soil disturbance with the exception of large-scale tree removal projects where heavy equipment is employed.

Mechanical treatment for fuel reduction generates large quantities of non-native and native plant material. There are several means of disposal of the vegetation. Chips and other plant material left on the surface soil will eventually degrade and contribute to organic matter and nutrients that improve soil productivity and ability to absorb runoff. Often vegetation is chipped up onsite where it can then be rebroadcasted for weed abatement and erosion control, chipped and removed from the site for use elsewhere for weed abatement, as biomass fuel, or disposal at a greenwaste recycling facility or a landfill. Wood can be left for use as firewood for the community in the project vicinity. A certain amount of wood can be left on site to decompose and provide habitat. The wood should be left in contact with the soil so as not to contribute to ladder fuels. Isolated snags may be left standing for habitat purposes. Broadcasting chips and leaving large debris parallel to the slope all constitute effective soil cover and contribute to controlling erosion by wind, water, and gravity.

Often larger rounds and branches are piled for burning onsite at a time when prescription requirements can be met. Burn piles burn for long periods of time at high temperatures and can impact soils close to the site of the burn (DeBano, 1998). The location of burn piles should be carefully sited away from slopes not only to prevent logs from rolling out of the fire, but to avoid creating a hydrophobic area on a slope that could result in a localized area of hydrophobicity that could accelerate runoff and erosion as well as be more likely to loss nutrient fire ash to stormwater erosion.

Wood from trees infected with Sudden Oak Death has the potential to continue the spread of the disease if wood is transported away from the site of origin. For that reason, all infected wood would be chipped or burned in piles onsite of the fuel reduction project.

Overall, impacts to soil resources from mechanical treatment projects would be adverse, short-term, and negligible to minor in impact intensity.

Wildland Urban Interface Initiative Program

Under Alternative A, projects would be restricted annually to 500 acres of prescribed burning and 500 acres of mechanical treatment in the Limantour Road, Highway One, Bolinas Ridge (fire only), and Estero FMUs. Projects within the Highway One FMU have the opportunity to build upon community projects proposed for the small community of Dogtown. Additional work

funded under the WUI initiative for the Dogtown area should considered during annual planning for FMP projects to identify the affected watersheds and assure than no more than 10% of the watershed is affected.

Maintenance of Fire Roads and Trails

Mowing, debris clearing, tree felling along roadways and other actions necessary to maintain reduced fuels and emergency vehicle access on park roads and trails would not affect soil resources in the project area. Actions occur within a 10-foot corridor on each side of the roadway and involve chainsaws, lopers, overhead pruning saws, weedwhips, small trucks, and a mower. With the exception of the mower, maintenance vehicles stay within the margins of the roadway and the actions do not affect soil resources. The mower could disturb restricted areas of surface soil while navigating along the corridor or occasionally cut into surface soils with the changes in topography. Mowing normally occurs after nourishing winter rains have ceased and prior to the beginning of fire season, to be able make the single pass of the mower as efficient as possible. Soils within the 10-foot corridor are largely protected from the action of the mower by the accumulation of the newly cut grass, thatch from previous years and the dense near-surface root system of annual grasses and forbs. Because of the timing of the mowing and the protection afforded by vegetation, thatch, and roots, any erosion of exposed surface soils would be negligible.

Vegetation Clearing Around Buildings

Clearing around buildings can involve pickup trucks, a mower, chain saws, overhead pruning saws, weedwhips, riding mowers, and lopers. Soil disturbance would be limited to occasional contact of the mower blade with soil depending on the topography. Vegetation is cleared around buildings in early spring so residual growth of cut vegetation occurs and the limited areas where soils are exposed would be protected against erosion by wind or water by regrowth, existing thatch cover, and the near-surface root system of annual grasses and forbs. Because of this protection and the timing of the mowing, any erosion of exposed surface soils would be negligible.

Public Information and Education

Fire information and education actions proposed for all alternatives would have no beneficial or adverse effects on soil resources in the project area.

Fire Cache/Park Headquarters Relocation and Construction

The proposed structure would cover approximately 3000 square feet of ground surface. Additional concrete aprons and paved surfaces would be approximately 1000 square feet. Vehicle parking would be gravel. Vehicle washing would occur within curbed paved area and runoff and accidental spills would be captured and wastewater suctioned into a holding tank. The 4,000 square feet of soil affected are located in the most developed area of the park. The ground surface is nearly level and loss of soils during construction could be minimized through the application of standard erosion control practices such as erosion control fabric placed to

prevent soil movement. Orange habitat fencing set back from the building envelope and delineating the extent of the working area would prevent unwarranted soil compaction and surface disturbance by heavy equipment.

Cumulative Impacts

Cumulative impacts are those that would occur not as a direct result of this planning effort or actions proposed in the alternative, but in the vicinity of the project area. Appendix C has a list of other planning activities in the project area that are unrelated to this fire management plan. In addition, the Seashore experiences a major wildland fire every few decades. Such a fire would affect all of the same resources described in this EIS under the sections Prescribed Fire and Wildfire and Suppression. It is therefore included in the discussions of cumulative impacts.

Erosion. Assuming a moderate to fairly large wildland fire, the effects to soil resources would be adverse, short- to long-term and moderate to major in intensity. Depending on the severity of the burn, slopes and rainfall intensity, productive topsoil could be lost through erosion throughout the burn area. The soils with the highest potential for erosion are on very steep slopes along the top of Inverness Ridge in Bishop pine, Douglas-fir, and redwood forests. During the very large and catastrophic 12,000+ acre Vision Fire, forested areas and woodlands accounted for roughly 75% of the vegetation burned. Fire intensity was highest on the steep slopes of Inverness Ridge which also have highly erosive granitic soils (BAER, 1996). Active upstream channel cutting was observed in drainages on the west slope of Inverness Ridge. Evidence of erosion was recorded particularly in the granitic soils on the steeper slopes. Many of the soil types within the project area were outside of the burn perimeter of the 1995 fire and the potential effects of fire on rates of erosion have not been observed. Monitoring of other post-fire areas reports elevated erosion rates for two or more years following fires. From research on the Vision Fire, it should be noted that the burn area ranged from 50 to 100% of many watersheds in the burn area. The impacts to soil in these watersheds were major, but within three years, many conditions were trending back to normal (soil chemistry, hydrophobicity, etc.)

Major impacts to soil resources during the Vision fire resulted from compaction and erosion from the use of heavy equipment to construct fire lines, staging areas, and travel corridors for emergency vehicles during fire suppression. Potential effects from heavy equipment include: soil compaction, concentration of runoff water by roads, landings and yarding corridors, mixing of native soil horizon from fire line creation, loss of productive surface soils to erosion due to loss of soil anchoring vegetation cover, increase in potential for surface soil failures (debris flows), soil contamination from the application of fire suppression and retardant compounds, alteration of soil properties as a result of prescribed or wildland fire (e.g., hydrophobicity/water repellency, death of soil organisms, reduced water storage by removal of large woody material, and organic matter overlying and within the soils. De Bano and others (1996) found that moderately and severely burned watersheds took 7 and 14 years, respectively to recover from full effects of the loss of surface soils in the post-fire period of accelerated erosion. Although this is potentially a serious impact, the soils would recover, preventing an impairment of park resources.

Changes in Soil Characteristics. The granitic soils of Inverness Ridge and soils supporting certain chaparral species, such as manzanita, may be prone to develop hydrophobicity. Research has shown that effects of hydrophobicity may last as long as three to four years, but investigations following the Vision Fire experience indicated that water repellency was noted in areas that experience severe fire intensity but had significantly diminished in effect by the second winter storm season following the fire. Areas prone to hydrophobicity and high rates of runoff and low rates of infiltration may also experience mass slope failures and debris flows in steeply sloped areas.

Reduced populations of beneficial organisms and occasionally pathogens follow fires. Also, an immediate decrease in organic material and available nutrients occurs; this is corrected over time by nutrient recycling. Elevation in soil temperatures may contribute to a slower re-establishment of effective soil cover.

As noted above, the use of heavy equipment and other suppression activities can have a variety of adverse effects on soils, some of which can be long lasting. Soil and soil productivity is slow to replace in human timescales; therefore, post-burn management activities that accelerate erosion or create soil compaction must be avoided or minimized to the greatest extent possible. While large-scale erosion control projects are sometimes implemented after a large fire, this has not always proved to be effective from a safety or cost-perspective. Practices that increase soil infiltration and reducing runoff (e.g., seeding) may also increase water storage in the soil and increase the hazard of landslides (Booker et al., 1993). This is why suppression activities are currently more focused on avoiding specific down-slope resources, such as areas of prior slope failure, water bodies, creeks and structures (Oster, 2003). Sensitive resources, such as stream channels, riparian areas, wetlands, or other special biological areas, are also avoided if possible.

Beyond a large-scale wildfire, cumulative impacts to soils would occur from some of the building projects identified in Appendix C. The Giacomini Wetlands Project converts grazing lands to wetlands inundating 560 acres of soils largely formed under wetland conditions. Rather than an impact to soil resources, this represents a restoration of wetland soil resources to a native state. The series of riparian protection projects proposed for the Olema Valley would reduce erosion into the riparian corridors and include exclusionary fencing on Blueline Creek, Giacomini Creek, Cheda Creek, and other tributaries.

Conclusion

The impacts of prescribed burning under Alternative A to rate of soil erosion would be negligible to minor depending on the amount of effective soil cover that remains after the fire and the steepness of the slopes involved. Impacts from erosion would be kept to no more than 10% of soils in the watershed through the use of annual burn plans and NPS review. Soil productivity and chemistry would experience adverse, short-term and negligible to minor impacts from prescribed burning. In the short-term, there may be negligible to minor short-term impacts on organisms in the soils and nutrients in the upper few inches of the soil horizons.

The same types of impacts to soils, e.g., erosion and changes in soil productivity and chemistry, would result from typical wildland fires in the park each year. Suppression activities would add

impacts to soils primarily from compaction. Because the number of acres burned by wildfires each year remains quite low, impacts to soils would be short-term, adverse and negligible or minor.

Soil disturbance from mechanical treatment is not expected to result in more than negligible or minor short-term adverse impacts.

Moderate to major short- to long-term adverse impacts to soils from a very large or catastrophic wildland fire are possible. Increases in erosion, formation of hydrophobic soils, gullying, channel cutting, slope failure, and changes to the physical, chemical, and biological nature of soils in the project area are likely in the event of this type of fire. Suppression activities could have additional adverse, short- to long-term moderate to major impacts from soil compaction, mixing, reduced infiltration, loss of vegetation and changes in soils that prevent quick revegetation. Avoiding sensitive resources could keep impacts from becoming major and adverse.

No impairment to park soil resources is expected.

Alternative B

The actions associated with Alternative B could result in both beneficial and adverse effects on soil resources within all 10 of the FMUs within the project area though actions in certain FMUs are limited to either prescribed fire or mechanical treatment. Actions would be permitted within the following FMUs: Tomales Point (mechanical only), Estero, Inverness Ridge (prescribed fire only), Limantour Road, Highway One, Bolinas Ridge (prescribed fire only), Wilderness North, Wilderness South, Palomarin, and Minimum Management FMUs (mechanical treatment only). Alternative B calls for prescribed burning of up to 1000 acres each year, and mechanical treatment of up to an additional 1000 acres.

Analysis

Prescribed Fire

As in Alternative A, impacts to soil resources from prescribed fire projects would be adverse, short-term, and negligible to minor in intensity primarily because the conditions that permit a prescribed burn to proceed also limit the intensity that the fire typically achieves. As noted above, fire intensity is the factor that most affects soil productivity and soil stability by the combustion of organic matter, beneficial organisms, and overlying vegetation cover, volatilization of nutrients, and pulsing of hydrophobic compounds into surface soils. In prescribed burns, fire intensities are would be low with only scattered areas of where readily ignitable fuels burn with a higher intensity. Prescribed fires are also conducted on moderately sloped terrain. These factors all combine to limit the amount of ensuing erosion. Changes to soil characteristics would be similar to Alternative A and limited primarily to the upper soil horizon and correctable through natural processes such as nutrient recycling.

Typically, prescribed fires do not burn with sufficient intensity in the project area to fully combust effective soil cover and expose bare mineral soil except in very limited areas. However,

the Seashore nevertheless proposes to limit the aerial extent of annual burning within one FMP watershed to 10% or less of the total watershed area to ensure no greater than minor impacts to soils from erosion resulting from prescribed burns.

While the annual 500-acre cap of prescribed burning under Alternative A automatically limits the potential watershed level effects on erosion to a negligible or minor effect, larger projects are permissible under the 1,000-acre annual cap in Alternative B. Ten percent of the total acreage of three of the watersheds where FMUs slated for prescribed burning in Alternative B is less than 1,000 acres per year. If a group of projects proposed for several FMUs were sited within one of these three watersheds, there is a potential for more than 10% of the effective soil cover in that watershed to be affected.

Mitigation measures relative to watershed level planning are proposed to assure that erosion rates within any one watershed would conform to the conclusions of environmental effect reached in this EIS, e.g., would be no more than moderate in intensity. It would be triggered when proposed actions have the potential to exceed 10% of the total area of one or more FMP watersheds in one year. Mitigation Measure S-2 assures that planning considers the watershed scale, and if a potential effect is identified, that a specific assessment be conducted for the work plan to assure the conformance of watershed level effects with this EIS. Under Alternative B, Mitigation Measure S-2 would be triggered if the annual work plan includes projects that account for more than 10% of the Bolinas Drainages, Olema Creek Watershed, or the Pine Gulch Watershed. As shown in Table 42, the combined project acreage must exceed 790 acres in Bolinas Drainages, 939 acres in Olema Creek Watershed, and 506 acres in Pine Gulch Watershed.

Once it is confirmed that an annual plan for prescribed burning would exceed the 10% level of area in these smaller watersheds, Mitigation Measure S-2 requires an interdisciplinary team evaluation, chaired by the Fire Management Officer, to document the degree of conformance of the proposed actions with the assessment conducted for this EIS.

Table 42. Alternative B: Potential Watershed Level Effects

Watershed (Total Acreage)	**Alternative B FMUs in each Watershed**	**Alt. B FMU acreage within this Watershed**	**% of Watershed within this FMU**	**Potential for More than Minor Impact on Watershed Soils**
Bolinas Drainages Watershed (7,902 acres)	Bolinas Ridge Highway One Palomarin	259 acres 521 acres 1,823 acres	3.3% 6.6% 23.1%	Yes. 10% of watershed = 790 acres which is < 1,000 acres (annual cap Alt. B) and Total FMU acreage in watershed = 33% which could exceeds the 10% target. Mitigation S-2 is triggered.
Drakes Bay Drainages Watershed (12,758 acres)	Limantour Road Palomarin Wilderness N Wilderness S	820 acres 35 acres 327 acres 1,439 acres	6.4% 0.3% 2.6% 11.3%	No. 10% of watershed = 1,276 acres which is >* 1,000 acres (annual cap Alt. B).

Watershed (Total Acreage)	Alternative B FMUs in each Watershed	Alt. B FMU acreage within this Watershed	% of Watershed within this FMU	Potential for More than Minor Impact on Watershed Soils
Drakes Estero Watershed (17,720 acres)	Estero Inverness Ridge Limantour Road Wilderness N	1636 acres 924 acres 2543 acres 74 acres	9.2% 5.2 % 14.3% 0.4%	No. 10% of watershed = 1,772 acres which is >* 1,000 acres (annual cap Alt. B).
Lagunitas Creek Watershed (53,161 acres)	Bolinas Ridge	1339 acres	2.5%	No. 10% of watershed = 5,316 acres which is >* 1,000 acres (annual cap Alt. B).
Olema Creek Watershed (9,397 acres)	Bolinas Ridge Highway One	606 acres 1347 acres	6.4% 14%	Yes. 10% of watershed = 940 acres which is <* 1,000 acres (annual cap Alt. B) and Total FMU acreage in watershed = 20.4% which could exceed the 10% target. Mitigation S-2 is triggered.
Pine Gulch Creek Watershed (5,064 acres)	Bolinas Ridge Highway One Wilderness S	177 acres 1,012 acres 780 acres	3.5% 14% 8.3%	Yes. 10% of watershed = 506 acres which is <* 1,000 acres (annual cap Alt. B) and Total FMU acreage in watershed = 25.8% which could exceed the 10% target. Mitigation S-2 is triggered.
Tomales Bay Watershed (29,218 acres)	Inverness Ridge Limantour Road Wilderness N	326 acres 755 acres 1,190 acres	1.1% 2.6% 4.1%	No. 10% of watershed = 2,922 acres which is >* 1,000 acres (annual cap Alt. B).

There are two findings that could result from the watershed level assessment. Either the annual work plan would conform to or would exceed the level of effect predicted in the FMP EIS. Conformance would show that the proposed actions do include more than 10% and less than 25% of one FMP watershed but effects on the rate of erosion would be readily correctable by standard erosion control practices and would not result in a major impact. Documentation prepared by the interdisciplinary team must be sufficient to demonstrate that the project or projects conformance for the impact areas addressed in the EIS: soils, water quality, vegetation, rare or threatened species, aesthetics, park operations, or visitor experience. The definition of effect must conform to the methodologies applied in this EIS. Documentation would include project-level conditions sufficient where necessary to minimize or avoid major impacts to resources. The completed documentation will be signed by the Superintendent and added to the administrative record for this NEPA process, demonstrating conformance with this EIS. If the assessment found that the work plan does not conform to the findings of this EIS, a separate NEPA review process would be initiated.

Wildland Fire and Suppression

The level of impact to soils from wildland fires or suppression actions in an average year would not change from the level of impacts under Alternative A.

Mechanical Treatments

Alternative B permits twice the level of mechanical treatment than Alternative A. Despite the increase in acreage, the potential effects to soil resources are essentially the same as in Alternative A, as mechanical treatments normally do not disturb surface soils. As with Alternative A, burning of piled materials is used to dispose of cut vegetation. Under Alternative B, roughly twice as much material would need to be recycled chips or firewood, burned in piles, reused as biomass fuel or lumber, or legally disposed. Native plant materials and certain non-natives such as broom can be chipped and broadcast back into the area treated and contributes to effective soil cover. Areas supporting broom typically have such a large number of broom seeds in the soil that the chipped material can serve to help abate the resprouting of seedlings.

Soils below the burn piles can be subject to changes in productivity due to the concentrated effects of high intensity fire. Areas affected would be very limited in extent and would not significantly contribute to increase in soil erosion or decreases in soil productivity. Under Alternative B, impacts to soil resources from mechanical treatment would be adverse, short-term and negligible to minor in intensity.

Actions Common to All Alternatives

Wildland Urban Interface Initiative Program

Under Alternative B, there is much greater potential for in-park projects to complement those community projects funded by the WUI program. By definition, WUI projects are approved in part due to the proximity of the proposal area to the federal wildland interface. The potential to develop projects across management boundaries improves the effectiveness of the individual federal efforts and the community efforts. For example, fuel reduction projects within the Inverness Ridge FMU would build upon risk reduction achieved through matching efforts in Paradise Ranch Estates. Work in the Palomarin and Pine Gulch FMUs would improve the overall effectiveness of efforts funded for the Bolinas community. The overall fuel reduction achieved in Alternative B would provide greater beneficial effects than the limited opportunities provided under Alternative A, however, there is potential for soil disturbance to occur in a limited area where projects overlap jurisdictional boundaries. Mitigation measures require that the Superintendent assure that NPS funded projects for fire management actions in the PRNS Wildland Urban Interface retain sufficient funding in reserve from the full budget to purchase and install erosion control measures found to be required as conditions of NPS project review. Equivalent erosion control must be built into and funded for park and community projects affecting essentially the same soil resource area.

Maintenance of Fire Roads and Trails

Maintenance actions for fire roads and trails would be identical to Alternative A and, as in Alternative A, the limited exposed of surface soils from mowing actions would negligibly affect the rate of erosion. Other soil characteristics would not be affected.

Vegetation Clearing Around Buildings

Clearing around buildings would involve identical actions to those described for Alternative A and would result in negligible effects to the rate of erosion.

Public Information and Education

Fire Information and Education actions proposed for all alternatives would have no beneficial or adverse effects on soil resources in the project area.

Fire Monitoring

Actions associated with the fire-monitoring program are largely observational and non-invasive and would not affect soil resources in the project area.

Fire Cache/Park Headquarters Relocation and Construction

No change to the fire cache proposal occurs under Alternative B. Impacts under Alternative B are the same as those assessed under Alternative A.

Cumulative Impacts

Under Alternative B, impacts from a catastrophic wildland fire event similar to the 12,354-acre Vision Fire would have adverse, major, and long-term impacts to soil resources similar to under Alternative A. As Alternative B permits a higher amount of mechanical treatment and prescribed burning annually than Alternative B, twice as much acreage is treated to reduce fuels than in Alternative A. A primary focus of the actions would be to reduce fuels in the interface area with residential and commercial development. Over time, as more and more acreage is treated and maintained, potential effects from high fire intensity to soil resources would be reduced in the treated areas.

Conclusion

The impacts of prescribed burning under Alternative B on the rate of erosion of park soil resources would be negligible to minor depending on the amount of effective soil cover remaining after a fire and the steepness of the slopes involved. Although impacts from erosion would be greater than those in Alternative A, they would be kept to no more than 10% of soils within a watershed through the use of annual burn plans and NPS review as proscribed in Mitigation Measure S-2. As in Alternative A, soil productivity and chemistry would experience adverse, short-term and negligible to minor impacts from prescribed burning, although the

acreage experiencing these impacts would increase. In the short-term, there may be negligible to minor short-term impacts on organisms in the soils and nutrients in the upper few inches of the soil horizons.

Impacts to soils from wildland fires and suppression in an average year in the park would be the same as in Alternative A.

As in Alternative A, soil disturbance from mechanical treatment is not expected to result in more than negligible or minor short-term adverse impacts.

Moderate to major short- to long-term adverse impacts to soils from a very large or catastrophic wildland fire are possible. Increases in erosion, formation of hydrophobic soils, gullying, channel cutting, slope failure, and changes to the physical, chemical, and biological nature of soils in the project area are likely in the event of this type of fire. Suppression activities could have additional adverse, short- to long-term moderate to major impacts from soil compaction, mixing, reduced infiltration, loss of vegetation, and changes in soils that prevent quick revegetation. Avoiding sensitive resources could keep impacts from becoming major and adverse.

No impairment to park soil resources is expected.

Alternative C

The actions associated with Alternative C could result in both beneficial and adverse effects on soil resources within all project area FMUs though actions.

Analysis

Prescribed Fire

As in Alternative A, impacts to soil resources under Alternative C would be adverse, short-term and negligible to minor in intensity. Prescribed burns could be conducted in up to 2,000 acres per year but the increase in acreage would not translate to fourfold increase in effect to soil resources. Mitigation Measure S-1 assures that burn plans address erosion potential and that erosion control plans developed for the burn plans are reviewed by a qualified subject matter expert. Mitigation Measure S-2 assures that impacts on the rate of erosion on a watershed scale disturb no more 10 % of the watershed area unless a specific assessment is conducted to assure that resultant erosion would be readily correctable by standard erosion control practices.

Under Alternative C, the annual cap of 2,000 acres per year is larger than 10% of the area of nearly all of the FMP watersheds with the exception of the two largest watersheds – Lagunitas Creek and Tomales Bay. Under Alternative C, Mitigation Measure S-2 would be incorporated into the preparation process for the prescribed burning annual work plan. When submitted for consideration, the Fire Management Officer would identify the amount of total acres proposed for prescribed burning in each watershed. If the total amount of project acreage exceeds 10% of the total watershed acreage, an interdisciplinary team as directed by Mitigation Measure S-2 would conduct a conformance assessment. The findings of the assessment would be approved

by the Superintendent, responsible for NEPA compliance on the park level (NPS, 2000). The conformance assessment would be added to the administrative record for the FMP EIS.

Table 43. Alternative C: Potential Watershed Level Effects

Watershed (Total Acreage)	Alternative C FMUs in each Watershed	Alt. C FMU acreage within this Watershed	% of Watershed within this FMU	Potential for Moderate or Major Impact on Watershed Soils
Bolinas Drainages Watershed (7,902 acres)	Bolinas Ridge Highway One Palomarin	259 acres 521 acres 1,823 acres	3.3% 6.6% 23.1%	Yes. 10% of watershed = 790 acres which is <* 2,000 acres (annual cap Alt. C) and Total FMU acreage in watershed = 33% which exceeds the 10% target. Mitigation S-1 is triggered.
Drakes Bay Drainages Watershed (12,758 acres)	Headlands Limantour Road Palomarin Wilderness N Wilderness S	462 acres 820 acres 35 acres 327 acres 1,439 acres	3.6% 6.4% 0.3% 2.6% 11.3%	Yes. 10% of watershed = 1,276 acres which is <* 2,000 acres (annual cap Alt. C) and Total FMU acreage in watershed = 50% which exceeds the 10% target. Mitigation S-1 is triggered.
Drakes Estero Watershed (17,720 acres)	Estero Inverness Ridge Limantour Road Wilderness N	1636 acres 924 acres 2543 acres 74 acres	9.2% 5.2 % 14.3% 0.4%	Yes. 10% of watershed = 1,772 acres which is <* 2,000 acres (annual cap Alt. C) and Total FMU acreage in watershed = 29.1% which exceeds the 10% target. Mitigation S-1 is triggered.
Lagunitas Creek Watershed (53,161 acres)	Bolinas Ridge	1339 acres	2.5%	No. 10% of watershed = 5,316 acres which is >* 2,000 acres (annual cap Alt. C).
Olema Creek Watershed (9,397 acres)`	Bolinas Ridge Highway One	606 acres 1347 acres	6.4% 14%	Yes. 10% of watershed = 940 acres which is <* 2,000 acres (annual cap Alt. C) and Total FMU acreage in watershed = 20.4% which exceeds the 10% target. Mitigation S-1 is triggered.
Pacific Drainages Watershed (10,503 acres)	Headlands Tomales Point	419 acres 923 acres	4.0% 8.8%	Yes. 10% of watershed = 1,050 acres which is <* 2,000 acres (annual cap Alt. C) and Total FMU acreage in watershed = 12.8% which exceeds the 10% target. Mitigation S-1 is triggered.
Pine Gulch Creek Watershed (5,064 acres)	Bolinas Ridge Highway One Wilderness S	177 acres 1,012 acres 780 acres	3.5% 14% 8.3%	Yes. 10% of watershed = 506 acres which is <* 2,000 acres (annual cap Alt. C) and Total FMU acreage in watershed = 17.8% which exceeds the 10% target. Mitigation S-1 is triggered.
Tomales Bay Watershed (29,218 acres)	Inverness Ridge Limantour Road Wilderness N	326 acres 755 acres 1,190 acres	1.1% 2.6% 4.1%	No. 10% of watershed = 2,922 acres which is >* 2,000 acres (annual cap Alt. C).

Wildland Fire and Suppression

No changes in impacts to soils from average annual wildland fires and suppression compared to Alternative A are expected.

Mechanical Treatments

Alternative C permits three times the level of mechanical treatment than Alternative A. Despite the increase in acreage, the potential effects to soil resources are essentially the same as in Alternative A. The key is targeting erosion prone areas within an area to be treated for fuel reduction. Standard erosion control strategies would be sufficient to correct minor erosion problems. Areas with highly erodible soils and steep slopes would not be suitable for mechanical treatments. As with Alternative A, burning of piled materials is used to dispose of cut vegetation. Under Alternative C, roughly three times as much material would need to be recycled chips or firewood, burned in piles, reused as biomass fuel or lumber, or legally disposed. Native plant materials and certain non-natives such as broom can be chipped and broadcast back into the area treated and contributes to effective soil cover.

Actions Common to All Alternatives

Wildland Urban Interface Initiative Program

Under Alternative C, projects within NPS managed lands could treat 2,000 acres annually with prescribed burning and 1,500 acres of mechanical treatment. Compared to Alternative A, Alternative C presents many more opportunities for in-park projects to complement those community projects funded by the WUI program. Projects that benefit Inverness, Inverness Park, Dogtown, Olema, Bolinas, and Point Reyes Station could be paired with extension projects within the park. Projects within the park could target not only fuel reduction but also alternative evacuation routes for both park visitors and area residents. Impacts to soil resources would be controllable by standard erosion control practices and project siting away from steep slopes and highly erodible soils.

Maintenance of Fire Roads and Trails

Maintenance actions for fire roads and trails would be identical to Alternative A and, as in Alternative A, the limited exposed of surface soils from mowing actions would negligibly affect the rate of erosion. Other soil characteristics would not be affected.

Vegetation Clearing Around Buildings

Clearing around buildings would involve identical actions to those described for Alternative A and would result in negligible effects to the rate of erosion.

Public Information and Education

Fire information and education actions proposed for all alternatives would have no beneficial or adverse effects on soil resources in the project area.

Fire Monitoring

Actions associated with the fire-monitoring program are largely observational and non-invasive and would not affect soil resources in the project area.

Fire Cache/Park Headquarters Relocation and Construction

No change to the fire cache proposal occurs under Alternative C. Impacts under Alternative C are the same as those assessed under Alternative A.

Cumulative Impacts

Alternative C permits four times as much prescribed burning and three times as much mechanical treatment as is allowed under Alternative A. Ideally, after 5 years of implementation, 2,500 acres and 10,000 acres could be treated by prescribed fire in Alternative A and Alternative C, respectively. The caps on mechanical treatment would allow 2,500 acres and 7,500 acres of fuel management under Alternative A and Alternative C, respectively. Alternative C treats 12,500 more acres for fuel reduction over a five-year period than Alternative A. If fuel reduction targets critical areas important for wildland fire containment and suppression, Alternative C would be more effective than either Alternative A or B in lowering the risk of a catastrophic fire with its associated effects on soil erosion and productivity. In the long-term, though the potential impacts to soil resources from wildland fire and suppression actions would persist, the risk of a wildland fire and the overall fuel loading would be reduced in the project area in comparison to Alternative A. Despite this reduction in risk, the chance of a moderate, large, or catastrophic fire similar to the Vision Fire would remain with the potential for moderate to major short- to long-term adverse impacts to soil through erosion and changes in soil characteristics as the other alternatives.

Conclusion

The impacts of prescribed burning under Alternative C on the rate of erosion of park soils would be negligible to minor depending on the amount of effective soil cover that remains after the fire and the steepness of the slopes involved. Typically, prescribed fires burn cooler than wildland fire and leave more effective soil cover in place. Prescribed burns are not planned for either gentle or moderately sloped areas that are less prone to erosion. Further, prescribed burns incorporate erosion control techniques as part of the burn proposal. These best management practices are implemented and monitored once installed.

Although impacts from erosion would be greater than those in Alternative A, they would be kept to no more than 10% of soils in the watershed through the use of annual burn plans and NPS review as described in Mitigation Measure S-2. With the exception of the two largest watersheds

in the project area - Tomales Bay and Lagunitas Creek – FMU lands constitute more than 10% of the total acreage in the remaining 6 watersheds. Annual plans would be subject to mitigation measures to assure that no more than 10% of a FMP watershed is proposed for FMP actions each year.

As in Alternative A, soil productivity and chemistry would experience adverse, short-term and negligible to minor impacts from prescribed burning, although the acreage experiencing these impacts would be greater than in Alternative A. The impacts are reversible in the short-term and the areas affected have a scattered distribution that reflects overlying burn piles or long-burning fuels. In the short-term, there may be negligible to minor short-term impacts on organisms in the soils and nutrients in the upper few inches of the soil horizons. Beneficial effects can also result from the destruction or reduction of harmful pathogens and fungi that attack plants and roots.

Impacts to soils from wildland fires and suppression in an average year in the park would be the same as in Alternative A.

As in Alternative A, soil disturbance from mechanical treatment is not expected to result in more than negligible or minor short-term adverse impacts.

Moderate to major short- to long-term adverse impacts to soils from a very large or catastrophic wildland fire are possible. Increases in erosion, formation of hydrophobic soils, gullying, channel cutting, slope failure, and changes to the physical, chemical, and biological nature of soils in the project area are likely in the event of this type of fire. Suppression activities could have additional adverse, short- to long-term moderate to major impacts from soil compaction, mixing, reduced infiltration, loss of vegetation and changes in soils that prevent quick revegetation. Avoiding sensitive resources could keep impacts from becoming major and adverse.

No impairment to park soil resources is expected.

IMPACTS TO AIR QUALITY

The standard smoke management techniques listed below are incorporated into all proposed FMP alternatives. Prescribed burns, controlled wildland fire, and suppression actions would be conducted incorporating these best management practices to lessen the effects of smoke and other emissions on human health, ecological health, air quality, and visibility.

If recommended by BAAQMD, burn plans submitted for review could be modified to provide reduced production of pollutants. Recommendations for reducing pollutants are described in the 2002 US Department of Agriculture General Technical Report, Wildland Fire in Ecosystem, Effects of Fire on Air Quality. Recommendations include modifying burn plans reducing the area burned, reducing fuel loading (e.g., mowing and understory thinning away), or managing fuel consumption. Treatments to reduce overall air emissions would include:

- Mowing grass and reducing density of vegetation in brushlands.

- Mechanical treatment of forested areas by removing standing or downed trees, understory thinning, thinning of forests, and creation of shaded firebreaks.

- More frequent, less intense burns to prevent unwanted vegetation from becoming established in clearings or in forest understory.

- Scheduling burns prior to the appearance of new growth.

Increasing combustion efficiency or shifting the majority of combustion away from the smoldering phase and into the more efficient flaming phase would reduce emissions, except NOx, which is produced in greater quantities at higher temperatures. Methods to accomplish this would include pile or windrow burning, rapid mop-up, and shortened fire duration. Pile or windrow burning would generate more heat and burn more efficiently and be most effective in reducing forest fuel rather than brush type fuels.

The park would develop a *Smoke Communication Strategy* to guide management of smoke events during prescribed fires, managed wildland fires, suppression actions, and fires occurring outside the park. Notification of proposed burns would be disseminated through local media and posting to provide adequate advance notice to persons with sensitivities to smoke that burning is planned. Information would be provided to visitors, employees, and residents in smoke affected areas regarding health issues and concerns. The park would monitor particulate levels in the park during large smoke events to provide data for future assessments.

$PM_{2.5}$ monitoring data would be collected at Bear Valley in the Point Reyes National Seashore. Data collected would be shared with local, regional, and national air quality agencies and databases, and can provide a basis for planning fire management or fire fighting activities.

To reduce smoke and pollutant generation during the late summer, early fall, efforts would be made to burn fuel concentrations, piles, landings, and jackpots outside of the prescribed burning season to increase the number of units that can be burned without overloading the airshed on days with good dispersal conditions (NWCG, 2001).

To avoid impacts to visibility in the Class I PRNS portion of the project areas, burning would be avoided on holidays or other periods when recreational visitation is typically high (NWCG, 2001).

To avoid public health and nuisance impacts to neighboring communities prescribed burns would be conducted under meteorological conditions that would avoid smoke drifting into sensitive residential areas and transport smoke away from populated areas. Planning for prescribed burning would also consider the smoldering period to avoid siting fires where downslope winds during the night could carry smoke into residential areas at the base of ridges (NWCG, 2001).

Alternative A

Under Alternative A, a maximum of 500 acres of prescribed burning and 500 acres of mechanical treatment could occur annually within the FMUs.

All prescribed burning at PRNS and the northern lands of GGNRA has been, and would continue to be planned and performed under the auspices of the BAAQMD Smoke Management Program. That program is incorporated in the State Implementation Plan (SIP) for the BAAQMD. The SIP is managed by BAAQMD staff to ensure that all ambient air quality standards and Clean Air Act provisions are met and public health is protected. Prior to igniting a prescribed fire, PRNS Fire Management staff must submit a burn plan to the BAAQMD Smoke Management Program, and obtain meteorological approval to burn from that program. It is the responsibility of these permitting agencies to coordinate the numbers of fires burning in one area. These efforts would ensure that annual emissions from fire management actions implemented under the PRNS FMP do not exceed state or federal standards.

Analysis

Prescribed Fire and Unplanned Ignitions

Emissions. Smoke from unplanned ignitions and prescribed fire is a complex mixture of carbon, tars, liquids, and gases. The major pollutants from fire that are monitored under the Clean Air Act by the BAAQMD are particulates (PM_{10} and $PM_{2.5}$), volatile organic compounds (VOC), and carbon monoxide (CO), and nitrogen oxides (NO_x). NOx is produced in relatively small quantities compared to the other pollutants.

As described in the Methodology section, air emissions associated with the amount of burning under Alternative A were estimated using the FOFEM model. The vegetation types used in modeling the emissions are based the principal vegetation communities found at actual prescribed burning project sites in the project area. The burn sites modeled were selected to equal the annual maximum allowable acreage – 500 acres - of prescribed burning under Alternative A. The vegetation type modeled is based on an estimate of the composition of the actual burn sites - roughly 58% grassland, 41% shrublands, and 1% forest. This translates into 291 acres of grasslands, 204 acres of shrublands, and 5 acres of understory burns conducted forested areas as part of limited trials. Included in the model are emissions produced by 30 acres wildland fire occurring annually and split between the three primary vegetation types – 20 acres of grassland, 8 acres of shrublands, and 2 acres of forest.

Transport and fire vehicles such as trucks, engines, and water tenders, etc. would be onsite at the fire to patrol and stand by on alert. For wildfires, air emissions would be generated by chainsaws and graders clearing fuels or providing access, transporting fire fighters, and by heavy equipment and engines used to fight the fire. Wildfire emissions listed may be underestimated since they do not include emissions from fire-fighting aircraft.

The annual levels of emissions produced by prescribed and wildfire burning for Alternative A are summarized in Table 44. The emissions shown represent a conservative estimate; it was assumed that all acres are being burned for the first time. In the event that a prescribed fire unit is burned more than once in the 7-year period, the emissions from that unit would be reduced by approximately 33%.

Table 44. Projected Annual Fire Management Emissions Under Alternative A

Action Type	Acres	Fire Emissions (tons/yr) [a]				
		PM_{10}	**$PM_{2.5}$**	**VOC**	**CO**	**NOx**
Prescribed Fire [b]	495 acres	21.0	17.8	5.5	45.7	1.3
Prescribed Fire Understory Burn	5 acres	2.9	2.4	1.4	28.3	0.8
Wildfire	30 acres	6.0	5.1	2.9	59.4	1.7
Equipment Use During Prescribed Burning or Wildfire Suppression	N/A	0.1	0.1	0.1	1.3	0
Mechanical Treatment	500 acres	0.1	0.1	0.1	1.2	0
Total	1030 acres	30.1	25.9	9.8	134.8	3.8

[a] PM_{10} = Suspended Particulate, $PM_{2.5}$ = Fine Particulate Matter, VOC = volatile organic compounds (methane), CO = Carbon Monoxide, NOx = Nitrogen Oxides
[b] Includes grass and coastal scrub ecosystems and their respective emission factors for prescribed burning.
Source: URS, 2003.

All prescribed burns proposed by the park are approved for ignition by BAAQMD with the objective of maintaining Bay Area Air Basin air pollutant emissions within the national ambient air quality standards listed in Table 44. BAAQMD's decision to permit ignition of prescribed burns is supported by the best available meteorology and forecasting at the time of ignition and allows the agency to coordinate the location and amount of emissions generated simultaneously by prescribed burning in one air basin.

Particulates and Regional Haze. Air quality at the project site is generally good due to the prevailing westerly winds. The air quality of the project area can become degraded when the east Pacific high pressure system becomes displaced; this typically occurs in late summer and early fall when the major atmospheric systems undergo a seasonal change. The result can be a general haze in the air basin, significantly impairing visibility (Sullivan et al., 2001).

The behavior of a smoke plume from a fire, including the direction and elevation that the smoke plume moves, and resulting concentrations at ground level, is highly dependent on elevation and dynamic meteorological conditions at the time. Generally, the higher the elevation of the burn, the greater the mixing volume of air to dilute it is required. Higher elevation winds also tend to better dilute and disperse smoke at lower concentrations. High-level winds may transport dispersed smoke particles large distances. Complex geography and weather patterns complicate the ability to exactly predict the quantity and destination of smoke particles in the plume. Fall and early winter generally have climatic conditions least favorable to smoke dispersion, while spring and summer generally have better conditions for dispersing smoke. Within the project area, prescribed burning is scheduled from early fall through late spring with specific meteorological requirements in the burn prescription for conditions with lower potential for loss of control of the fire and smoke dispersal.

The level of regional haze is an important issue for PRNS, a Class I airshed. The effect of Alternative A on regional haze is assessed by the contribution of additional particulate matter to the airshed through implementation of allowable actions and relative to the size of the

management area. As shown in Table 44, all actions under Alternative A could contribute an additional 30.1 tons of PM_{10} to the airshed annually or 0.7 pounds per acre managed based on the FMP management area of 90,000 acres. This additional contribution would be a long-term adverse but negligible effect on regional haze as the additional contribution of PM_{10} would be less than 1 pound per year per acre managed.[1]

Localized Smoke Effects. Generally, smoke effects from prescribed burning last only as long as the duration of the fire management action. Smoke behavior varies with the amount and type of fuel burned. In areas such as the Douglas-fir forests on Inverness Ridge, the fuel load consists of decades of accumulated duff. Because it tends to smolder, duff produces relatively more particulates than burning vegetation. Areas of fire-dependent vegetation, such as the Bishop pine forest that burned in the Vision Fire, have high fuel loading due to fire-induced regrowth but the duff layer would have been lost in the 1995 fire. A higher percentage of fuels would therefore burn in the flaming phase if another fire occurred in this forest, resulting in a significantly lower rate of emissions and smoke generation.

Dense smoke would likely occur in the vicinity closest to wildfire operations. Unhealthful concentrations of smoke would be most likely to affect fire personnel immediately adjacent to the fire. Most smoke plumes from fire suppression operations would disperse at middle to upper elevations and, occasionally, under unfavorable wind conditions, into the more heavily populated areas of Marin County.

In Alternative A, prescribed burning would be conducted primarily in grass and shrub ecosystems. Burns to thin understory in forested areas would be roughly 5 acres per year. Burning would occur in the Limantour, Estero, Highway One, and Bolinas FMUs. Under prevailing wind conditions, smoke generation would generally be confined to the southwest of Highway One or the interior of the park away from the principal residential communities of Olema Valley, Inverness and Inverness Park, and Bolinas. Ranches and residences along Highway One and ranches east of Estero FMU would experience short-term, negligible or minor adverse smoke impacts from prescribed burning.

Mechanical Treatment

Emissions from mechanical treatments were calculated from two sources. The primary source is from equipment used to remove or control vegetation. Mechanical treatments could include mowing roadside vegetation, limbing up trees along roads and trails, creating or maintaining defensible space around structures, and creating or maintaining shaded fuel breaks. Emissions could be generated by the transport vehicles for staff, use of wood chippers, chain saws and weed whips to cut and mulch vegetation, and skidders and excavators to move cut trees.

The second source of emissions is generated by machines used to prepare for and control prescribed burns. Air emissions would be generated by mowers, chain saws and weed whips used to reduce vegetation height and density along the fire perimeter and pre-treat the burn area.

[1] Based on total tons per year of PM_{10} emissions divided by 90,000-acre project area. 30.1 tons per year X 2000 lbs per ton/ 90,000 acre project area = 0.7 pounds produced per acre managed.

The PM_{10} emissions generated by machinery, vehicles and tools contribute to the adverse, long-term negligible effect on regional haze. Particulate emission levels are shown in Table 44 and discussed under Particulates and Regional Haze.

Fire Information/Education

Actions involved with the fire education program would have neither beneficial nor adverse effects on air quality.

Fire Cache/Park Headquarters Relocation and Construction

The construction of the fire cache building at Bear Valley would have effects on local air quality during the construction period. Construction would generate dust during site preparation that could be controlled through routine watering of dry surface soils and stockpiles. The site is nearly level so only minor site recontouring would be required. Equipment used to construction the buildings would include a front loader, grader, trucks, cement mixer, portable generators, and hand power tools. Construction actions would be short-term lasting three months with limited ground disturbance. Impacts to air quality from emissions of construction-related equipment and grading would result in an adverse, short-term, negligible effect on air quality.

Fire Effects and Fuel Management Research

Actions involved with monitoring, fire effects, and fuel management research would have neither beneficial nor adverse effects on air quality.

Cumulative Effects

Ongoing effects to air quality would occur from implementing Wildland Urban Interface (WUI) projects, maintenance of fire roads and trails, vegetation clearing around buildings, traffic in the park and region, and other sources. The same types of equipment as described above under Mechanical Treatment could be used for clearing, roads and trails and WUI projects, and approximate emissions are included in Table 45 below.

The assessment of cumulative impacts includes the occurrence of a large, high intensity, catastrophic fire similar to the 1995 Vision Fire, which burnt 12,500 acres – 6,000 acres of grasslands, 4,000 acres of shrubs, and 2,500 acres of woodlands. Inclusion of a catastrophic fire of the scale of the Vision Fire as part of the cumulative impact scenario is recognition that current fuel loading within the project area is at a high enough level to support the possibility of a recurrence within the lifetime of the Fire Management Plan.

Table 45. Determination of Cumulative Effect on Air Quality Alternative A

	Emissions (tons/year) [a]				
	PM_{10}	$PM_{2.5}$	VOC	CO	NOx
Alt A: Emissions from FMP Actions[b]	30	25.4	9.9	134.8	3.9
Large-scale Wildfire[c]	6,801	5,763	3,395	72,689	2,077
WUI Community Projects[d]	0.0	0.0	1.0	3.0	0.1
Total Cumulative Emissions @ FMP Year 1	6,831	5,789	3,406	72,826	2,081
Total Cumulative Emissions @ FMP Year 10	6,831	5,789	3,406	72,826	2,081
Cumulative Effect on Air Quality Alt. A, Year 1	Short-term, adverse, major effect on air quality				
% Change in Emissions @ Year 10 of Alt. A Compared to Year 1 of Alt. A	0% change or essentially equivalent to Year 1				
Cumulative Effect on Air Quality Alt. A, Year 10	Short-term, adverse, major effect on air quality				

[a] PM_{10} = Suspended Particulate, $PM_{2.5}$ = Fine Particulate Matter, VOC = volatile organic compounds, CO = Carbon Monoxide
[b] includes acres of 500 acres of prescribed burning with associated mechanical preparation, 500 acres of mechanical treatment and 30 acres of wildfire and mechanical treatment during suppression.
[c] equivalent in scale to the 1995 Vision Fire.
[d] Mechanical treatment only; no prescribed fire.
Source: URS. 2003

As shown in Table 45, the cumulative scenario of a large-scale fire occurring in conjunction with routine FMP actions would constitute a short-term, major, adverse effect on air quality. Modeling indicates the fire hazard potential in Year 10 of the FMP would remain essentially unchanged from that in Year 1. The number of acres treated each year under Alternative A is too limited to make substantial gains on overall fuel reduction within the project area. The cumulative effects on air quality of emissions generated at Year 1 would be essentially the same as in Year 10.

Prescribed burning and mechanical thinning would be geared to controlling exotics and reducing fuels primarily along roadways in four FMUs rather than park-wide. Some of the areas untreated by Alternative A actions include the Douglas-fir forest in the Wilderness FMUs and the bishop pine and shrub communities adjacent to Inverness Ridge residential areas. These untreated areas would continue to be a source of high concern under Alternative A. The potential would continue to exist for large wildfires sufficient to cause significant air quality impacts regionally, especially in the late summer and early fall after vegetation dries and warm, dry easterly winds are common. Smoke impacts from large wildfires could be noticeable at considerable distances inland or along the coast, including in populated areas. The potential adverse, short-term major cumulative effect on air quality is essentially the same in Year 10 of Alternative A implementation as in Year 1.

Conclusion

Particulate emissions generated annually under Alternative A from all FMP actions and wildfires would have a long-term, adverse, but negligible effect on regional haze. Ranches and residences along Highway One and ranches east of Estero FMU could experience infrequent short-term, negligible to minor adverse smoke effects from prescribed burning.

The annual acreage treatment under Alternative A would not appreciably reduce the potential size or severity of a catastrophic wildfire even after a decade of implementation. The cumulative

effect on air quality would be short-term, adverse and major at both Year 1 of implementation and at Year 10.

The effects of the fire management program would not represent an impairment of important park resources including the Class I airshed status of PRNS including protection of resources from the effects of contaminants.

Alternative B

Under Alternative B, a maximum of 1,000 acres of prescribed burning and 1,000 acres of mechanical treatment could occur annually within the FMUs.

Analysis

Prescribed Fire and Unplanned Ignitions

Emissions. FOFEM modeling for Alternative B is based on a mock annual work plan of actual prescribed fire project sites comprised of 491 acres of grasslands, 358 acres of shrubs, and 153 of forested understory. The work plan sites are both in PRNS and northern GGGNRA lands with a total acreage equivalent to the maximum annual allowable 1,000 acres. As with Alternative A, representative annual occurrence of unplanned ignitions is 30 acres per year of high intensity wildfire occurring in 20 acres of grassland, 8 acres of shrublands, and 2 acres of forest.

Prescribed burning activity under Alternative B would expand the annual acreage in grass and brush ecosystems compared to Alternative A and include more than 150 acres of understory clearing and pile burning in the forested areas. In addition to the FMUs that would be treated under Alternative A, Alternative B includes the two Wilderness FMUs supporting forested areas that have not burned in at least a century. On a per acre basis, the forested areas in Alternative B produces much higher emission rates on a per acre basis than the grassland/scrublands that comprise nearly all of the acreage treated in Alternative A. The greater level of emissions generated by Alternative B would allow the reduction of fuels at a faster rate than allowed under Alternative A. The goal of the fuel reduction is to reduce the overall potential severity, rate of spread and air pollution emissions that could occur with a large-scale forest fire in the park.

Table 46. Projected Annual Fire Management Emissions under Alternative B

Fire Type	Acres	Fire Emissions (tons/yr) [a]				
		PM_{10}	$PM_{2.5}$	VOC	CO	NOx
Alt B: Prescribed Fires [b]	849 acres	36.8	31.1	9.7	80.0	2.3
Alt B: Prescribed Burns in Forested Understory[c]	153 acres	87.4	74.1	41.8	866.5	24.8
Wildfire	30 acres	6.0	5.1	2.9	59.4	1.7
Equipment Use During Prescribed Burning and Wildfire Suppression	N/A	0.2	0.2	1.5	6.3	0.2
Alt. B: Mechanical Treatment [c]	1,000 acres	0.1	0.1	0.2	2.4	0.1
Totals for Alternative B	2,032 acres	130.5	110.6	56	1,012.6	29

[a] PM_{10} = Suspended Particulate, $PM_{2.5}$ = Fine Particulate Matter, VOC = volatile organic compounds (methane), CO = Carbon Monoxide, NOx = Nitrogen Oxides
[b] Includes grass and coastal scrub ecosystems and their respective emission factors for prescribed burning.
[c.] Includes 1,000 acres of mechanical treatment annually in addition to emissions generated from equipment use during suppression actions and in preparation and execution of prescribed burning.
Source: URS, 2003.

Particulates and Regional Haze**.** Alternative B would produce nearly 3 times more particulates than Alternative A. PM_{10} could be generated at an annual rate of 2.86 pounds per acre managed.[2] This constitutes a long-term, adverse, minor effect on regional haze. A minor effect occurs with particulate generation between 1 and 5 pounds per acre managed per year. The effect is considered long-term as FMP actions would continue to contribute particulates on an annual basis until a level of ecological stability is reached when fuels on half of the FMU acreage is effectively reduced. This would occur at approximately 23 years into FMP implementation. At that point, annual levels of FMP actions could be reduced with associated reductions in particulate generation. During the life of the FMP, roughly 10 to 20 years, the particulate rate would continue to be generated at approximately 2.86 pounds per managed acre per year and constitute a long-term, minor adverse effect on regional haze that should be considered in calculations for long-range, air basin-wide planning goals.

Localized Smoke Effects. Impacts of prescribed fire activity in the surrounding communities would be similar to those described under Alternative A, but with greater frequency. Smoke dispersal from prescribed fires could affect the residents of Inverness, Inverness Park, and possibly the ranches in the north of PRNS as well as ranches along Highway 1 as in Alternative A. The same may be true for residents on the mesa area north of Bolinas. The requirements of burn prescriptions call for conditions that maximize smoke dispersal to the extent allowable without compromising control of the prescribed burn. As a precaution, prescribed burn perimeters would be generously buffered from any developed areas as a precaution. However, prevailing winds could result in smoke being blown towards the communities in the vicinity of the project area. In cases such as this, residents and the community at-large would be notified in advance of prescribed burning. Potential effects of nuisance smoke in the general locality of the prescribed burn would constitute a short-term, adverse, negligible to moderate impact from nuisance smoke.

Mechanical Treatment

Emissions produced by the mechanical treatment of 1,000 acres were modeled using standard generation factors for typical equipment used in these projects. Hours of use per acre are based on the experience of the PRNS Fire Management Officer. Projects included a mix of mowing, understory treatment, shrub density reduction, creation of shaded fuel breaks and roadside clearance treatment. Also modeled was equipment use in support of preparation and control of prescribed burns and the emissions generated by equipment and vehicle use in suppressing wildfire. As shown in Table 46, emissions from mechanical treatment are a negligible component of overall emissions generated annually under Alternative B but still contribute to the

[2] Based on total tons per year of PM_{10} emissions divided by 90,000-acre project area. 129.6 tons per year x 2000 lbs per ton/ 90,000 acre project area = 2.88 pounds produced per acre managed.

long-term, adverse, minor effect on regional haze, which is assessed on an annual basis as one emission level.

Fire Information/Education

Actions involved with the fire education program would have neither beneficial nor adverse effects on air quality.

Fire Cache/Park Headquarters Relocation and Construction

Effects of the construction of the fire cache building at Bear Valley are equivalent to those noted for Alternative A. Dust and emissions generated by heavy equipment during construction of the fire cache would be an adverse, short-term, negligible effect on air quality.

Fire Effects and Fuel Management Research

Actions involved with monitoring, fire effects, and fuel management research would have neither beneficial nor adverse effects on air quality.

Cumulative Effect

Several assumptions needed to be made in order to analyze the cumulative effects of annual fire management actions and a large-scale, catastrophic wildfire. The maximum allowable acreage of annual treatment under Alternative B would double the amount of fuel reduction achieved each year compared to Alternative A, the No Action Alternative. This doubling of annual treatment produces a progressive reduction in the size and severity of the large-scale fire until eventually the project area is returned to a more balanced return fire interval approximately 23 years into project implementation when half of the FMU acreage would have been treated and maintained. An important assumption is that the 2,000 acres treated annually under Alternative B would results in a corresponding reduction in the scale and severity of the large-scale wildfire that comprises the cumulative scenario.

If a large fire occurred within a few years of implementation of Alternative B, its scale is more likely to be similar to that generated under Alternative A. Three years into implementation, Alternative B would have begun to yield a noticeable reduction in fuel loading throughout the project site. The scale and intensity of a large-scale wildfire could reasonably be assumed to be proportionally downsized so that three years into implementation, the potential air emissions generated by a large-scale fire would be reduced roughly 17% compared to the emission potential in Year 1. By the Year 10 of implementation, sufficient fuel reduction actions would have occurred to reduce potential emissions 55% compared to Alternative A representing a short-term, major, beneficial cumulative effect on air quality.

By Year 23 (and beyond the planning horizon of this FMP), a more natural fire regime over a wide portion of the park would be accomplished by consistently expanding the treated acreage and reducing the size and severity of a large-scale wildland fire. A catastrophic fire at Year 23

would affect 2,500 acres rather than 12,500 acres (equivalent to the Vision Fire) and would produce 84% less emissions than the Vision Fire equivalent. .

Cumulative effects are assessed at both FMP inception (Year 1) and Year 10 of implementation, nearly halfway towards the goal of more natural fire regime. By year 10, FMP actions would have been effective in reducing the scale of a potential catastrophic fire by 50% to 6,250 acres.

Table 47. Determination of Cumulative Effect on Air Quality Alternative B

#		Emissions (tons/year) [a]				
		PM_{10}	$PM_{2.5}$	VOC	CO	NOx
1	Alt B: Emissions from FMP Actions[b]	130.5	110.6	56	1,012.6	29
2	Emissions of Large-scale Wildfire, Year 1[c]	6,801	5,763	3,395	72,689	2,077
3	WUI Community Projects[d]	0.0	0.0	1.0	3.0	0.1
4	Total Cumulative Emissions @ FMP Year 1 (1+2+3)	6,931.5	5,873.6	3,452	73,704.6	2,101.1
5	Emissions of Large-scale Wildfire, Year 10[e]	3,050	2,585	1,517	32,405	926
6	Total Cumulative Emissions @ FMP Year 10 (1+3+5)	3,180.5	2,695.6	1,574	33,420.6	955.1
7	% Change in Emissions @ Year 10 Compared to Year 1 (6÷4)-1.0	54.1% reduction in potential emissions				
8	Cumulative Effect on Air Quality of Alt. B, Year 10 Compared to Alt. A Year 10	Short-term, major, beneficial, cumulative effect on air quality				

[a] PM_{10} = Suspended Particulate, $PM_{2.5}$ = Fine Particulate Matter, VOC = volatile organic compounds, CO = Carbon Monoxide
[b] includes acres of 1,000 acres of prescribed burning with associated mechanical preparation, 1,000 acres of mechanical treatment, 30 acres of wildfire.
[c] equivalent in scale to the 1995 Vision Fire.
[d] Mechanical treatment only; no prescribed fire.
[e] 10 years of FMP actions have effectively reduced the potential size of the large-scale wildfire by 50% to 6,250 acres.
Source: URS. 2003

At Year 1 of FMP implementation, the potential scale of a catastrophic wildfire is the same for all alternatives. Alternative B doubles the number of acres treated annually to reduce fuel loading compared to the No Action Alternative. Unlike treatments under Alternative A, the annual cap on acreage treatment in Alternative B is sufficient to begin effectively reducing the potential risk of a large-scale fire in the project area. Each year, as a larger area of the FMUs are treated and maintained, the potential severity and extent of a catastrophic wildfire is correspondingly reduced. This would also reduce the level of emissions produced each year as the FMP is implemented. At Year 10 of Alternative B, the size of a potential large-scale fire would be half that under Alternative A. This 6,250-acre fire would present a short-term, major adverse effect on air quality in and of itself. However, relative to the potential emissions that would be generated under the No Action Alternative, Year 10 of Alternative B would be a relative short-term, major, beneficial effect on air quality by producing nearly 46% less emissions than under Alternative A.

Conclusion

On an annual basis, Alternative B would generate higher levels of particulate emissions than the No Action Alternative; twice as many acres would be subject to FMP actions each year. Alternative B would produce 2.86 pounds of PM_{10} per acre managed a long-term, adverse, minor effect on regional haze. This additional contribution would be offset by the long-term opportunity presented by Alternative B to achieve a major, beneficial reduction in the emissions that could result from a catastrophic fire as compared to the cumulative effect under Alternative A. Nuisance smoke would be an infrequent, short-term, adverse, negligible to moderate air quality impact for residents near prescribed burns during the duration of the burn.

The effects of the fire management program would not represent an impairment of important park resources including the Class I airshed status of PRNS including protection of resources from the effects of contaminants.

Alternative C

Under Alternative C, a maximum of 2,000 acres of prescribed burning and 1,500 acres of mechanical treatment could occur annually within the FMUs.

Analysis

Prescribed Fire and Unplanned Ignitions

Emissions**.** Modeling of emissions under Alternative C is based on a representative work plan comprised of actual project area burn sites totaling 2,000 acres. The project sites include 968 acres of grasslands, 756 acres of shrublands, and 276 acres of understory forest burns annually. Understory burning produces very high emissions compared to prescribed burns in grass or coastal scrub. The No Action Alternative included only 5 acres of understory prescription burning compared to the 276 acres modeled for Alternative C. So even if the annual acreage permitted for prescribed burning is only four times greater under Alternative C compared to the No Action Alternative, the levels of emissions produced are many times greater than the difference in the acreage amounts alone. For example, understory burning of 5 acres under Alternative A would generate 2.9 tons per year of PM_{10} while understory burning of 276 acres per year in Alternative C would produce 157.7 tons per year of PM10. So there is no direct correlation between the amounts of emissions produced and increasing the allowable acres fourfold. The increase in emissions is more dependent on the type of fuels treated than the amount of acreage included.

Table 48. Projected Annual Fire Management Emissions under Alternative C

Fire Type	Acres	Fire Emissions (tons/yr) [a]				
		PM_{10}	$PM_{2.5}$	VOC	CO	NOx
Alt C: Prescribed Fires [b]	1,724 acres	77.1	65.2	20.0	163.8	4.7
Alt C: Prescribed Burns in Forested Understory[c]	276 acres	157.7	133.7	75.3	1,563.1	44.7
Wildfire	30 acres	6.0	5.1	2.9	59.4	1.7

Equipment Use During Prescribed Burning and Wildfire Suppression	N/A	0.3	0.3	2.8	11.8	0.3
Alt. C: Mechanical Treatment [c]	1,500 acre	0.2	0.2	0.3	3.6	0.1
Totals for Alternative C	3,530 acres	241.3	205	101.3	1,801.7	51.5

[a] PM_{10} = Suspended Particulate, $PM_{2.5}$ = Fine Particulate Matter, VOC = volatile organic compounds (methane), CO = Carbon Monoxide, NOx = Nitrogen Oxides

[b] Includes grass and coastal scrub ecosystems and their respective emission factors for prescribed burning.

[c.] Includes 1,000 acres of mechanical treatment annually in addition to emissions generated from equipment use during suppression actions and in preparation and execution of prescribed burning.

Source: URS, 2003.

Particulates and Regional Haze. All actions under Alternative C would generate 5.3 pounds per acre managed of PM_{10}. The contribution to regional haze would be considered long-term, as the contribution would be an addition to current ambient emissions over the implementation period of Alternative C. However, Alternative C has the shortest predicted implementation period of the FMP alternatives. Because the amount of acreage treated is the highest in Alternative C and the greatest number of forested acres are treated, a more stable fire condition – i.e., successful FMP implementation - is achieved in the shortest time period. The more stable fire condition is considered attained when half of the FMU acres have been treated and are being maintained at low fuel levels. Allowable annual actions under the No Action Alternative A are so limited both in acreage and FMUs treated that little or no progress is made towards the effective reduction of fuel loading in the project area. Alternative B achieves the lower hazard stable fire condition at Year 23 of implementation. Alternative C would greatly accelerate the process, achieving stable fire ecology at Year 13.

As a result of a shorter implementation period, the long-term contribution of additional PM_{10} to regional haze from implementation of Alternative C would be relatively short compared to Alternative A, which has no predictable length until goals are met. Over the 13-year period of implementation, PM_{10} emissions from Alternative C would be a long-term, adverse, moderate effect on regional haze. The 5.3 pounds per acre managed meets the criterion for moderate effect, i.e., greater than 5 pounds and less than 10 pounds annually per acre managed.

Localized Smoke Effects. Impacts of nuisance smoke due to prescribed fire in the surrounding communities would be similar to those described under Alternative A, though occurring with more frequency and, in the case of understory burns, more intensity. Nuisance smoke could be noticeable during the period of active burning to residents in Inverness, Inverness Park, the northern ranches, and residents of homes and ranches along Highway 1, and in Bolinas. If burns are conducted adjacent to one or more residences, it may be necessary to advise these residents to remain indoors during the course of the burn, perhaps for one day. Residents within fifteen miles of the park might occasionally notice a brief impact from prescribed burning activities, possibly in slightly increased haze or light smoke impacts. Visitors to the park would also encounter haze or smoke more frequently during late fall through early spring when burns are conducted. Beyond that range, prescribed burning impacts are unlikely to be noticeable with any frequency. Alternative C could have a short-term, adverse, minor to moderate effect on park visitors and area residents.

Mechanical Treatment

The annual emissions generated under Alternative C for mechanical treatment of 1,500 acres are shown in Table 48. Also shown are the emissions produced by equipment and vehicles used preparing for and controlled prescribed burns and during the suppression of wildfires. Emissions generated by mechanical treatment are a short-term, negligible adverse effect on regional haze when viewed in isolation. As contribution to regional haze is assessed by pounds per acre managed on an annual basis, these emissions are considered part of the full contribution of all actions under Alternative C to regional haze. These emissions would have a moderate, adverse, long-term effect on regional haze of which emissions from mechanical treatment are a negligible component.

Fire Information/Education

Actions involved with the fire education program would have neither beneficial nor adverse effects on air quality.

Fire Cache/Park Headquarters Relocation and Construction

The construction of the fire cache building at Bear Valley would have short-term, minor adverse effects on local air quality during the construction period as in Alternative A.

Fire Effects and Fuel Management Research

Actions involved with monitoring, fire effects, and fuel management research would have neither beneficial nor adverse effects on air quality.

Cumulative Effects

Past, present, and reasonably foreseeable projects that might have a cumulative impact under Alternative C would be the same as those for Alternative A for the first year of FMP implementation. As each year's fire management actions are completed, it is assumed that a corresponding reduction in the scale and intensity of a potential large-scale wildland fire is achieved. Because Alternative C treats the highest number of acres per year, the highest amount of forested acres, and includes all FMUs within the project area, this alternative would achieve more significant in-roads in reducing fuel loading in the shortest time period. A more stable fire ecology and less hazardous condition would be achieved by Year 13 of FMP implementation under Alternative C.

To compare the estimated emission potential under Alternative C, the level of effect on air quality achieved in Year 1 and Year 10 is compared to the cumulative effect of Alternative A and are presented in Table 49. At Year 10, 35,000 acres would have been either treated or retreated for maintenance under Alternative C. The corresponding reduction in the potential size of a large-scale wildland fire would be roughly 3,000 acres. This size fire event would produce approximately 80% less emissions than the Vision Fire-scale event possible under Alternative A or Year 1 of implementation of Alternative C. A 3000-acre wildfire, though much smaller than

the Vision Fire-scale event, would still produce a short-term, adverse and major effect on air quality and regional haze. However, relative to the 12,500-acre fire possible under Alternative A, Alternative C represents a short-term, major beneficial cumulative effect on air quality and regional haze.

Table 49. Determination of Cumulative Effect on Air Quality Alternative C

#		Emissions (tons/year) [a]				
		PM_{10}	$PM_{2.5}$	VOC	CO	NOx
1	Alt C: Emissions from FMP Actions[b]	241.3	205	101.3	1,801.7	51.5
2	Emissions of Large-scale Wildfire, Year 1[c]	6,801	5,763	3,395	72,689	2,077
3	WUI Community Projects[d]	0.0	0.0	1.0	3.0	0.1
4	Total Cumulative Emissions @ FMP Year 1 (1+2+3)	7,042.3	5,968.5	3,497.3	74,493.7	2,128.6
5	Emissions of Large-scale Wildfire, Year 10[e]	1,359	1,152	674	14,372	385
6	Total Cumulative Emissions @ FMP Year 10 (1+3+5)	1,600.3	1,357	776.3	16,176.7	436.6
7	% Change in Emissions @ Year 10 Compared to Year 1 (6÷4)-1.0	77.3% reduction in potential emissions				
8	Cumulative Effect on Air Quality of Alt. C, Year 10 Compared to Alt. A Year 10	Short-term, major, beneficial, cumulative effect on air quality				

[a] PM_{10} = Suspended Particulate, $PM_{2.5}$ = Fine Particulate Matter, VOC = volatile organic compounds, CO = Carbon Monoxide
[b] includes acres of 1,000 acres of prescribed burning with associated mechanical preparation, 1,000 acres of mechanical treatment, 30 acres of wildfire.
[c] equivalent in scale to the 1995 Vision Fire.
[d] Mechanical treatment only; no prescribed fire.
[e] 10 years of FMP actions have effectively reduced the potential size of the large-scale wildfire by 50% to 6,250 acres.
Source: URS. 2003

Conclusion

On an annual basis, Alternative C would generate the highest levels of particulate emissions compared to the No Action Alternative and Alternative B. This is a result of the greater number of acres treated each year and the larger number of forested acres, which produce the highest emission levels. Alternative C would produce 5.3 pounds of PM_{10} per acre managed a long-term, adverse, moderate effect on regional haze. Contributions of PM_{10} to regional haze would be a long-term, adverse, moderate effect for 13 years rather than the indeterminate period under Alternative A.

This additional contribution would be offset by the long-term opportunity presented by Alternative C to achieve a short-term, major, beneficial, cumulative effect on regional haze relative to the emissions produced under the cumulative scenario in Alternative A.

Nuisance smoke would be an infrequent, short-term, adverse, negligible to moderate air quality impact for residents near prescribed burns during the duration of the burn.

The effects of the fire management program would not represent an impairment of important park resources including the Class I airshed status of PRNS including protection of resources from the effects of contaminants.

IMPACTS TO WATER RESOURCES AND WATER QUALITY

Alternative A

Under this alternative, 500 acres of prescribed burning and approximately 500 acres of mechanical treatment would occur over an average year. The actions associated with Alternative A could affect water resources and water quality within the Estero, Limantour Road, Highway One, and Bolinas Ridge (mechanical treatment only) FMUs.

Analysis

Prescribed Fire

Prescribed fire could have impacts on water resources and water quality during site preparation (e.g., fire line construction) or as a direct result on the fire itself. As noted in the Affected Environment discussion, water quality can be affected by increases in total suspended solids (TSS) or increases in nutrients results from a fire. The features of a watershed, including soil conditions, overland flow, and other hydrologic variables could also be affected.

Fire changes vegetation, forest floor cover (e.g., ground vegetation, litter, or duff), structure, and soil properties, all of which can alter the movement of water over, or into, the soil. In the first years following a fire, watershed storage capacity is reduced and net surface runoff is increased as a result of reduced soil cover, lack of soil cover, and/or increased soil hydrophobicity (water repellency). These changes can result in channel extension, upland erosion, and stream channel incision. These changes to hillslope process result in increased discharges, soil erosion, and higher sediment yield, affecting aquatic habitat conditions within the watershed.

The heating of soils from prescribed or wildland fires can lead to development of a water repellent layer at or below the surface of the soil, a condition called hydrophobicity. This layer reduces the infiltration capacity of the soil and increases the potential for overland flow. The higher the fire intensity/severity, the deeper in the soil this layer will form. A water repellent layer below the soil surface is likely to cause more soil erosion than such a layer at the surface, as the soils that lie above the water repellent layer can be moved as a debris flow. Fire associated hydrophobic conditions decay over time as the integrity of the hydrophobic layer is reduced. In the case of the Vision Fire on Inverness Ridge, the hydrophobic layer was patchy by the end on the second winter after the fire (Collins and Ketcham, 2001). Water repellency is more common in coarse-textured soils, such as those derived from granite parent material. Hillslope process in burn areas with high fire intensities is most acutely affected by hydrophobic soil conditions.

Fire can reduce the capacity of slopes to attenuate rainfall through loss of vegetation and soil cover, and through reduction in soil permeability. After fire, overland flow and rills often

develop in areas where surface flow did not previously occur. Observations in the granitic soils of Inverness Ridge following the Mt. Vision Fire showed the effects of the fire to include channel network extension through rilling. Hydrologic storage capacity (ratio of runoff to precipitation) is further decreased through delivery of water through flow tubes consisting of abandoned animal burrows or rotted out root paths (Collins and Ketcham, 2001). In addition, the Vision Fire area after the first rains displaced most of the ash; the exposed soil quickly developed a crust of tine particles that essentially sealed the surface from infiltration. This was observed by Onda et al. (1996) who determined that during the initial storm of the season after the fire, the runoff ratio was 10 times higher than normal and 50% of the runoff was caused by the surface crust, not the hydrophobicity. Collins and Ketcham (2001) also found in the lower Muddy Hollow watershed after the Vision Fire minimum sediment increases of 2,626 tons/sq/mi/yr occurred. Sediment supply to lower Muddy Hollow Creek in the second year was 2.7 times higher to the lower watershed during second year after the fire than the first year. This is likely due to the lag time of sediment transport through a watershed.

Under prescribed fire, fuel moisture, weather conditions, time of day, spatial pattern of ignition, and other factors are effective means of controlling the fire. Given these controlling factors, prescribed fire would not generally result in high severity fire that would alter watershed conditions. Burn blocks would be limited in size (less than 200 acres). Burns would not be continuous up the vertical gradient of the watershed (meaning from the bottom/riparian area through mid-slope, and into or through the slope of the ridge.

Under prescribed fire parameters, fire in the duff layers would spread under variable conditions, but not with enough severity to cause extensive areas of hydrophobic soil.

In addition, prescribed fire in the duff layers would spread across the watershed under variable conditions so that burn severity would range locally from light to severe. Patches of extremely hydrophobic soils would be created in areas of high fuel loading where soils would be exposed to heating for a longer time and at a higher temperature than where fires burned in lighter fuels. However, these hydrophobic areas would be patchy in burned areas and not extensive because of the controlled burning conditions that are required to conduct prescribed fire. For example, weather, fuel moisture, and wind speed must be within certain limited parameters.

The effects would not typically be on a watershed scale because prescribed fires are less than 200 acres and the program would not treat more than 10% of the watershed in any one year. In addition, prescribed burning would be only in part of the watershed, either upper, lower, or middle sections, with limited intrusions into riparian areas. Increases in water yield and peak flows would occur on a watershed scale but would be within the natural range of variability. Because of the temperate climate in Point Reyes, vegetation growth is rapid and increases in sediment and nutrient yield fluctuations would be short-term (Wong, 2003). As a result, there would be only negligible erosion of primary and secondary stream channels as a result of increased runoff, and the recovery of riparian systems would occur quickly, in one to two years. Therefore, short-term and negligible to minor water quality impacts would result from increased surface runoff and soil erosion on a watershed scale.

Periodic prescribed fire would help keep plant communities within their natural range of variability. Fire frequency was about every 8-14 years before European settlement. Where fire return intervals are out of cycle, fuel accumulations can be well outside their natural range of variability, and when catastrophic fire occurs the impacts to water quality are severe (Ketcham, 2003).

Prescribed fire would be used as a means to reduce the severity and intensity of large-scale catastrophic fire that directly causes negative impacts to water quality such as increasing sediment loads. In addition prescribed fire would also limit the potential for catastrophic fire that could burn along the entire vertical gradient in the watershed and creating extensive hydrophobic soils resulting in increased sediment loads to watersheds (Ketcham, 2003). Because of the above, prescribed fire in the long-term would have beneficial effects on watersheds by reducing the severe impacts of a catastrophic fire that could extensively burn an entire watershed.

To sum, the effects of prescribed fire on watershed conditions would be beneficial, long-term, and moderate because of the restoration of natural hydrologic process. Effects on water quality would be adverse, minor and short-term from prescribed fire due to some limited degradation of water quality from soil disturbance, removal of the duff layer, and altered flow patterns.

Mechanical Treatments

Under this option, 500 acres would be treated by mechanical means, including hand cutting and mowing. Because of the labor-intensive nature of hand cutting, no more than about 100 acres could be treated by this means each year. Hand cutting activities would lead to soil compaction on a localized scale and would likely have a negligible effect on duff and topsoil layers, resulting in negligible direct impacts on watershed characteristics, including water yield, peak flows, sediment yield, nutrient yield, and stream system response. Thus, the effects of hand cutting would be adverse and short-term, but only negligible in intensity to water quality.

Hand cutting projects would be limited in size, with boundaries typically associated with only one portion of the slope (top, mid-slope, or bottom). Water yield and peak flows would increase only slightly, and within a small range of variability, thus sediment and nutrient yield would only see short-term fluctuations. As a result, there would be negligible channel response, with short-term effects, if any, in riparian systems.

Piles of cut wood debris would be burned. Pile burning could create small patches of hydrophobic soils, which, depending on conditions, could experience light to severe changes. Biological and physical characteristics of these patches would be expected to change. However, because of the small areas, the biological function of these areas would return very quickly, and the effect on a watershed scale would not be noticeable. The impact of pile burning on water quality would be adverse, short-term, and minor.

Mowing would be used in this alternative to treat the majority of acres. Mowing would be used where air quality, visitor use, or other management concerns prohibit burning or where mowing is the preferred option, such as where maintaining a cultural landscape. Mowing would lead to soil compaction on a localized scale, but would likely have a negligible effect on duff and topsoil

layers, resulting in negligible direct impacts on watershed characteristics, including water yield, peak flows, sediment yield, nutrient yield, and stream system response. Water quality impacts from mowing overall would be adverse, short-term, and negligible.

Overall, the watershed effects within these areas would be beneficial, long-term, and minor to moderate by reducing fuel loads and reestablishing the natural hydrological cycle as described under prescribed fire above. Where fire return intervals are out of cycle, fuel accumulations can be well outside their natural range of variability and when a watershed level wild fire occurs the impacts to water quality are severe (Ketcham, 2003).

Mitigation Measures

W-1. Individual burn plans would be written with enough detail to determine the extent of erosion within the burn area due to a) the prescribed burn and/or, b) mechanical treatments. Subject matter experts would determine if the erosion control plan submitted is sufficient to prevent long-term moderate or major impacts to the water resources and water quality. Strategies to minimize erosion and sediment transport to water resources associated with prescribed burning include avoiding oversteep slopes, timing burns to minimize erosion potential, or using erosion control devices after burns. Strategies to minimize erosion and sediment transport to water resources associated with mechanical treatment include avoiding oversteep slopes, avoiding scraping or clearing to bare mineral soil (leave duff layer), or installing erosion control devices as part of mechanical treatment (if necessary).

W-2. Watershed level planning would be used to assure that prescribed burning and/or mechanical treatment within any one watershed would conform to the conclusions of the environmental effect reached in this EIS (e.g., the impacts would be no more than moderate in intensity). Watershed level planning would be triggered when proposed actions have the potential to exceed 10% of the total area of one or more FMP watersheds in one year. This mitigation measure assures that planning considers the watershed scale and, if a potential effect is identified that a specific assessment be conducted for the burn plan to assure the conformance of the watershed level effects within this EIS.

The above two mitigation measures would ensure minimal impacts to water quality or aquatic wildlife. Alternative A would result in the prescribed burning of 500 acres or less, which, as Table 41 shows, is smaller than 10% of the acreage any of the watersheds proposed for treatment. Even if the annual plan for prescribed burning proposed work takes place in a single watershed, it would not be possible to exceed 10% of the acreage. Therefore, the effect of prescribed burning on 10% or less of the vegetation cover would normally be a negligible or minor short-term adverse effect. As noted above, if park review indicated that potential erosion would be greater than this even with the use of mitigation described above, additional environmental analysis would occur.

W-3. Helispots, staging areas and spike camps will be located at least 100 feet away from streams, creeks, and other water bodies.

W-4. All fireline (both handline and dozer line) would be rehabilitated as quickly as possible, which would include application of Burned Area Emergency Rehabilitation (BAER) techniques such as recontouring, soil stabilization as needed, and monitoring for erosion and treatment as necessary in the first winter following disturbance.

W-5. When developing prescribed burn boundaries, non-treatment buffer areas would be established around perennial, intermittent, and ephemeral channels associated with Lagunitas Creek, Olema Creek, Pine Gulch Creek, and other coastal drainages originating from Inverness Ridge. Some treatment within buffer areas, including hand removal of non-native species and "cool" burns of non-native grasses, may occur within these areas. Fire lines around these areas would be mowed - not graded or scraped - in order to leave a 100-foot vegetated buffer strip from burn areas.

Unplanned Ignitions, Wildfire, and Suppression

Annually, the park has approximately three unplanned ignitions resulting in 30 acres of vegetation impacted. Suppression activities in these areas would have potential to alter flow patterns and increase soil erosion because vegetation and organic litter would be removed to stop or hold a fire.

Erosion would be greatest along stretches of fire line that run down slope. Soil compaction and disturbance would occur with activities during both hand line preparation (a hand line is usually several feet wide where vegetation is removed to bare soil to stop a fire) and mop-up (clean-up after a fire is suppressed). Water bars and check dams would continue to be used as mitigation, to dissipate runoff and reduce erosion. Downed snags would create locally heavy areas of fuels that would, on a very small-scale, affect the temperature and residence time of a fire.

Holding Action and Monitoring Effects (water and retardant drops, helispots, and spike camps).

Helispots would be located at least 100 feet away from any stream or waterbody and typically on or near a topographic high. Because of the relatively small surface area and location, helispots would typically have little effect upon water quality or other watershed attributes. Spike camps for monitoring and holding crews would be located in similar areas as helispots. They have the potential to be larger, especially as crew-size increases, but even so, effects would be generally localized. Both helispots and spike camps would contribute to areas of increased compaction and disturbance in the soils if needed. Water quality effects of these actions would be adverse, short-term, and minor.

Retardant and suppressant compounds would not typically move into ground water or into surface water from runoff as they would be used carefully around surface waters because of potential effects upon aquatic organisms. Most fire retardants contain fertilizer type compounds, including ammonia and nitrogen. Although the half-life of these compounds in soil is short, they can cause changes in pristine terrestrial and aquatic ecosystems, especially to bodies of water that are otherwise low in nitrate/ammonia type nutrients like those in the study area. Additionally, ammonia itself can be quite toxic in aquatic habitats. Some retardants also contain preservatives that release cyanide that can be fatal to aquatic life. To minimize impact, pilots and

engine crews would be directed to avoid dropping retardants within 300 feet of wetlands, streams, and lakes. This buffer zone would eliminate any potential direct discharge to these water resources because soil would quickly absorb the retardant and vegetation would also impede flow to any water resource. The use of such a wide buffer zone would prevent moderate or major adverse effects from the use of retardants and suppressants, and would keep impacts to water quality and watersheds to short-term negligible or minor adverse effects.

Fire Information/Education

This would have no beneficial or adverse effects on water resources, the hydrology of the area, or water quality.

Fire Cache/Park Headquarters Relocation, and Construction

The proposed structure would cover approximately 3000 square feet of ground surface. Additional concrete aprons and paved surfaces would be approximately 1000 square feet. Vehicle parking would be gravel. Vehicle washing would occur within curbed paved area and runoff and accidental spills would be captured and wastewater suctioned into a holding tank. The 4,000 square feet of soil affected are located in the most developed area of the park. The ground surface is nearly level and loss of soils during construction could be minimized through the application of standard erosion control practices such as erosion control fabric placed to prevent soil movement. Orange habitat fencing set back from the building envelope and delineating the extent of the working area would prevent unwarranted soil compaction and surface disturbance by heavy equipment. Overall, the construction of a fire cache at Bear Valley would not have a beneficial or negative impact on water quality and water resources.

Fire Effects and Fuel Management Research

This would have no beneficial or adverse effects on water resources, the hydrology of the area, or water quality.

Cumulative Impacts

Cumulative impacts to water quality could occur from construction or compaction from activities described in Appendix C, or from a wild fire. When considered in combination with the minor to moderately beneficial impacts of projects (except a large-scale fire) of other projects listed in Appendix C, the cumulative impacts from Alternative A would be adverse, short-term, and minor. The majority of the impacts are related to short-term compaction of soils and disturbance to duff layers.

Extensive burned areas that may be continuous from ridgeline to slope bottom and include riparian areas characterize high-severity fires in Point Reyes such as the Vision Fire. Water yield and peak flows increase following high severity fire because soil infiltration rates decrease and there is little vegetation to intercept precipitation or organic litter (duff) to slow water runoff. Extensive and continuous areas of hydrophobic soils are created, further decreasing infiltration and increasing water yields. This was observed by Onda et al. (1996) who determined that during

the initial storm of the season after the fire, the runoff ratio was 10 times and the surface crust, not the hydrophobicity, caused 50% of the runoff. Collins and Ketcham (2001) also found in the lower Muddy Hollow watershed after the Vision Fire minimum sediment increases of 2,626 tons/sq/mi/yr occurred. Sediment supply was 2.7 times higher to the lower watershed during second year after the fire than the first year.

A large-scale fire would cause an increase in sediment and nutrient yields in the watershed and corresponding increased rates of erosion and sediment deposition in channels. This would impact both water quality and the physical characteristics of channels and their associated aquatic habitats. Channels would not reestablish their pre-fire character until the vegetation re-colonized and stabilized hill slopes and channel banks. However, because of burn severity in the riparian areas, reestablishment of vegetation would take several years. During extreme weather events, debris torrents would potentially scour streams, delaying restoration of the riparian community for even longer. Thus, with the cumulative impacts of a large-scale catastrophic fire, the effects of Alternative A on water resources and water quality include areas of adverse, potentially long-term, and major change. However, vegetation would return in the long run, as it has following the 12,000+ acre Vision Fire, and scouring and overland flow would return to rates within the natural rate of variability, preventing impairment of park resources.

Conclusion

To sum, the effects of prescribed fire on watershed conditions and natural hydrology of the burn areas through reducing the risk of catastrophic fire and returning more natural fire intervals would be beneficial, long-term, and moderate. Effects of prescribed fire to water quality related to increased erosion would be adverse, minor and short-term until vegetation is reestablished. Impacts from soil disturbance related to mechanical treatments would be adverse, short-term, and negligible to minor. However, the watershed effects within these areas treated by mechanical means would be beneficial, long-term, and minor to moderate.

In aggregate, actions implemented under this alternative would have adverse, short-term, and minor effects to water quality. In the long-term, the actions of Alternative A would have a beneficial, long-term, moderate to major effect in restoring the natural hydrology of the area.

A large-scale unplanned fire could have adverse, potentially long-term, and major impacts to both water quality and features of watersheds, including riparian zones and watercourses.

No impairment to park water resources would result from implementing Alternative A.

Alternative B

Analysis

Prescribed Fire

In this alternative 1000 acres of prescribed burning would occur over an average year. Although the number of acres treated by prescribed fire is increased above Alternative A, the types of

impacts from Alternative B are the same as those described for Alternative A. Also, because the burn units are dispersed throughout the park in the various FMUs (no concentration of impacts within a watershed) the total acres treated in relationship to the 90,000 acres within park boundaries is still relatively small (less than 2%). Therefore, beneficial impacts to the watershed from the removal of large fuel loads (protection from catastrophic fire) and the reestablishment of a natural hydrological process due to treatment with prescribed burning would still fall in the moderate range in the context of the entire study area. However, compared to Alternative A, benefits would be twice that of Alternative A because of the additional acres treated. Although effects on water quality from prescribed fire would occur over a larger area in this alternative relative to the No Action alternative, they would remain adverse, minor and short-term in the context of the entire study area. They may be quite noticeable on a localized basis compared to Alternative A, however.

Unplanned Ignitions, Wildfire, and Suppression

Same as Alternative A. Water quality effects of these actions would be adverse, short-term, and minor due to soil compaction and use of fire retardants. However, the overall acres, approximately 30, are minor compared to the total acres (90,000) within the park (less than 1%).

Mechanical Treatments

Under Alternative B, the total acres treated by mechanical means would increase to 1000. Although this is double that treated in Alternative A, it is still a relatively small (less than 2%) percentage of the 90,000 acres in the study area. In addition, treatment would be dispersed among eight FMUs (Alternative A would include mechanical treatment in three FMUs). Therefore in the context of the entire study area, benefits to watershed characteristics from mechanical treatment by reducing fuel loads and reestablishing the natural hydrological cycle would remain long-term, and minor to moderate as they are in Alternative A.

Water quality impacts from mechanical treatments would be adverse, short-term, and negligible due to soil disturbance and vegetation removal that may cause erosion. Overall, long-term, minor to moderate beneficial effects on the watershed would result from reestablishing natural hydrological cycles, eliminating exotic vegetation, and reducing the potential for catastrophic fire. Compared to alternative A, the relative impacts to both water quality and watershed characteristics may be readily noticeable on a localized basis as the number of acres treated would double.

Mitigation Measures

Same as Alternative A. While the annual 500-acre cap of prescribed burning under Alternative A automatically limits the potential watershed level effects on erosion to a negligible or minor effect, larger projects are permissible under the 1,000-acre annual cap in Alternative B. Ten percent of the total acreage of three of the watersheds where FMUs slated for prescribed burning in Alternative B is less than 1,000 acres per year. If a group of projects proposed for several FMUs were sited within one of these three watersheds, there is a potential for more than 10% of the effective soil cover in that watershed to be affected.

The W-2 mitigation measures relative to watershed level planning are proposed to assure that erosion rates within any one watershed would conform to the conclusions of environmental effect reached in this EIS, e.g., would be no more than moderate in intensity. It would be triggered when proposed actions have the potential to exceed 10% of the total area of one or more FMP watersheds in one year. Mitigation Measure W-2 assures that planning considers the watershed scale and, if a potential effect is identified, that a specific assessment be conducted for the work plan to assure the conformance of watershed level effects with this EIS. Under Alternative B, Mitigation W-2 would be triggered if the annual work plan includes projects that account for more than 10% of the Bolinas Drainages, Olema Creek Watershed, or the Pine Gulch Watershed. As shown in Table 42, the combined project acreage must exceed 790 acres in Bolinas Drainages, 939 acres in Olema Creek Watershed, and 506 acres in Pine Gulch Watershed.

Once it is confirmed that an annual plan for prescribed burning would exceed the 10% level of area in these smaller watersheds, Mitigation Measure W-2 requires an interdisciplinary team evaluation, chaired by the Fire Management Officer, to document the degree of conformance of the proposed actions with the assessment conducted for this FEIS.

Fire Information/Education

Same as Alternative A. Fire education and information programs would have no beneficial or adverse effects on water resources, the natural hydrologic process, and water quality.

Fire Cache/Park Headquarters Relocation, and Construction

Same as Alternative A. The construction of a fire cache at Bear Valley would not have a beneficial or negative impact on water quality and water resources. The building would be located at least 100 feet from riparian zones and temporary construction plastic fencing would be used to eliminate any sediment reaching the creek during rain events.

Fire Effects and Fuel Management Research

Fire research would have no beneficial or adverse effects on water resources and quality.

Cumulative Impacts

No cumulative impacts beyond those described for Alternative A would occur.

Conclusion

In the context of the 90,000 acre study area, the impacts to water quality and watershed characteristics of Alternative B would be nearly indistinguishable from Alternative A. Treatment with prescribed fire and through mechanical means would result in long-term, moderate to major benefits to watersheds from the reestablishment of the natural hydrological processes, elimination of exotics, and reduction of fuel loads and potential for catastrophic wildfire. Compared to No Action, the benefits could be quite noticeable on a localized basis.

Impacts to water quality over the entire study area from soil disturbance, erosion and sedimentation from these same activities would have similar adverse, short-term, and negligible to minor impacts to water quality as Alternative A. However, because the treated acreage would double in this alternative, localized impacts to water quality may be quite noticeable.

A large-scale unplanned fire could have adverse, potentially long-term, and major impacts to both water quality and features of watersheds, including riparian zones and watercourses.

No impairment to park water resources would occur from implementing Alternative B.

Alternative C

Analysis

Prescribed Fire
In this alternative 2000 acres of prescribed burning would occur over an average year. In the context of the 90,000 acre study area, treatment of 2000 acres would not have impacts to watersheds or water quality readily distinguishable from those in No Action. As in both Alternatives A and B, treatment would have beneficial, long-term and moderate impacts to water resources through reducing fuel loads and the potential for catastrophic fire, controlling exotic vegetation and reestablishing natural hydrological processes. However, even though the number of acres burned would remain relatively small, it would be four times the number treated in the No Action alternative, and twice that in Alternative B. Smaller scale positive changes in fuel loading, ground cover, soil condition and other features contributing to hydrologic processes may therefore be much more noticeable under Alternative C than the other alternatives.

This is true of short-term impacts to water quality as well. Although soil disturbance and resulting sedimentation from activities necessary to carry out or control prescribed burns would have on negligible or minor park wide adverse effects to water quality, localized erosion may be more noticeable or longer lasting under this alternative.

Unplanned Ignitions, Wildfire, and Suppression

Same as Alternative A. Water quality effects of unplanned ignitions and fire suppression actions would be adverse, short-term, and minor due to soil compaction and use of fire retardants. However, the overall acres, approximately 30, are minor compared to the total acres (90,000) within the park (less than 1%).

Mechanical Treatments

Although the total acres treated mechanically in this alternative is 1500 acres, this is still a small percentage (less than 2%) of the total study area, and compared to it would have only the same minor to moderate benefits to hydrological processes by controlling exotics, reducing the potential for catastrophic fire, and helping to reestablish natural hydrologic cycles as either Alternative A or C. Mechanical treatment would also be dispersed over a wider area than in the

No Action alternative, and so benefits to watersheds would be difficult to distinguish from other alternatives. However, as noted above, 1500 acres is significantly greater than the 500 acres Alternative A would treat, and on a local basis, improvements to hydrologic processes may be quite noticeable.

The same is true for water quality. Over the entire study area, water quality impacts from mechanical treatments would be adverse, short-term, and negligible to minor due to soil disturbance and vegetation removal that may cause erosion. However, because more acres are treated, it is likely that either a greater number of streams or other bodies of water would experience temporary sedimentation or higher turbidities in others than in the No Action alternative would occur.

Mitigation Measures

Same as Alternative A. FMP watersheds with the exception of the two largest watersheds – Lagunitas Creek and Tomales Bay. Under Alternative C, Mitigation Measure W-2 would be incorporated into the preparation process for the prescribed burning annual work plan. When submitted for consideration, the Fire Management Officer would identify the amount of total acres proposed for prescribed burning in each watershed. If the total amount of project acreage exceeds 10% of the total watershed acreage, an environmental analysis would be conducted by an interdisciplinary team as directed by Mitigation Measure W-2.

Fire Information/Education

Same as Alternative A. Fire education and information programs would have no beneficial or adverse effects on water resources, the natural hydrologic process, and water quality.

Fire Cache/Park Headquarters Relocation, and Construction

Same as Alternative A. The construction of a fire cache at Bear Valley would not have a beneficial or negative impact on water quality and water resources. The building would be located at least 100 feet from riparian zones and temporary construction plastic fencing would be used to eliminate any sediment reaching the creek during rain events.

Fire Effects and Fuel Management Research

The actions under this alternative would have no beneficial or adverse effects on water resources and quality.

Cumulative Impacts

No cumulative impacts different from those described under the No Action alternative would occur in Alternative C.

Conclusion

In the context of the 90,000 acre study area, the impacts to water quality and watershed characteristics of Alternative C would be difficult to distinguish from Alternative A. Treatment with prescribed fire and through mechanical means would result in long-term, moderate to major combined benefits to watersheds from the reestablishment of the natural hydrological processes, elimination of exotics, and reduction of fuel loads and potential for catastrophic wildfire. Compared to No Action or Alternative B, the benefits could be quite noticeable on a localized basis.

Impacts to water quality over the entire study area from soil disturbance, erosion, and sedimentation from these same activities would have similar adverse, short-term, and negligible to minor impacts to water quality as Alternative A. However, because the treated acreage would be quite a bit larger in this alternative, temporary localized impacts to water quality may be more noticeable.

A large-scale unplanned fire could have adverse, potentially long-term, and major impacts to both water quality and features of watersheds, including riparian zones and watercourses.

No impairment to park water resources would occur from implementing Alternative C.

IMPACTS TO VEGETATION

Types of impacts

Numerous activities associated with wildland fire, prescribed fire, wildland fire suppression, and mechanical treatments can have either adverse or beneficial impacts on vegetation. Impacts can be sustained by individual plants, or by plant communities. Examples of impacts to individual plants include direct mortality or physical damage resulting from burning, or from mowing or cutting vegetation for fireline. A plant community level impact would occur if cutting fireline or prescribed burning led to the establishment or spread of non-native invasive plants, which could alter plant community species diversity and function. Mitigation such as monitoring and the removal of non-native plants would limit these effects.

The impacts of fire on vegetation are a function of the severity of the fire itself and characteristics of the plants on the site. The ultimate response of a plant or a plant community to fire is related to the type of fire (e.g., surface vs. crown), fire behavior, fire duration, fire intensity, the season in which the fire burns, and how recently the area burned in the past. Fuel quantity and arrangement, fuel moisture content, topography (e.g., slope and aspect), wind speed, and the structure of the plant community itself cause the lethal heat zone to vary significantly in time and space (Miller, 2000). This means fire effects on plants can vary not only widely among fires, but also among different areas on the same fire.

Species and individual plants respond uniquely to fire based on plant age, vigor, morphology, reproductive strategies (e.g., seeders vs. sprouters), germination requirements, and phenological state at the time of the fire. Trees, shrubs, and herbaceous species all respond differently to fire,

and exhibit numerous strategies for post-fire colonization, including sprouting and seeding. The amount of subsurface heating that occurs, as well as the amount of organic matter removed from the soil surface affects plants and regeneration. Post-fire weather also influences post-fire species establishment (e.g., which species will recolonize the site and how quickly) and affects the success of newly established plants.

For the major groups of vascular plants (trees, shrubs, herbs, and grasses), the post-fire plant community, at least for the first few years following the fire, is comprised of species that have the following regeneration strategies:

- plants that survived the fire;
- plants that produced sprouts or suckers from the base or from protected aerial reproductive structures; or
- plants that established from seed (Miller, 2000).

Seedlings that establish on a burned site are derived from one of the following sources:

- seed was dispersed from plants that survived the fire (usually trees);
- seed was dispersed onto the site from adjacent unburned areas;
- seeds that were in the soil seed bank that were stimulated to germinate by the fire; or
- seeds that came from plants within the fire that resprouted following the fire (Miller, 2000).

Types of Effects From Prescribed Burning

Prescribed fire can result in direct mortality, can damage plants or seeds, and can change plant community structure and species composition. The primary difference, however, between unplanned wildland fire and prescribed fire is that prescribed fires are conducted under a rigid set of prescriptive parameters including air temperature, fuel moisture, wind speed, etc. Prescribed fire planners and managers, therefore, exercise careful control over when and where the burns occur, and site-specific prescriptions are developed to meet set objectives relative to vegetation.

The impacts associated with line construction, holding, monitoring, and mop-up of prescribed fires would be similar to those described in the following section for suppression of unplanned wildland fire. These impacts, however, would be less substantial with prescribed fire because they would be carefully planned to minimize impacts, and they would be implemented under controlled conditions.

Types of Effects from Wildland Fires and Suppression

The direct effects of unplanned wildland fires on vegetation can be substantial, including long-term, possibly permanent changes in plant species composition or percent cover, and the introduction or spread of non-native invasive plant species. However, in burned areas with a high component of surviving trees and resprouting native understory vegetation, within a few years it can be difficult to determine that a fire recently occurred (Miller, 2000).

Activities associated with suppression of wildland fire can kill or damage native vegetation. These activities include construction of fire control lines, firebreaks, or access roads; aerial drops of water or retardant; and post-suppression mop up.

Aerial drops of water or retardant release liquids onto burning or unburned areas. Most fire retardant contains fertilizer type compounds, including ammonia, nitrogen, and phosphorous that can change vegetation, especially in areas low in nitrate/ammonia type nutrients. Added nutrients can decrease growth of native vegetation and increase the establishment of non-native species that favor higher nutrient levels. Impacts can be mitigated by avoiding use of retardant or by using "clear" retardant that has minimal active nutrients within the mix. Physical damage to vegetation can be avoided by requesting that pilots fly aircraft quickly enough to dissipate water and retardant over larger, more linear areas.

Vegetation that may have survived the fire itself may be adversely affected by mop-up activities through soil disturbance, damage to aboveground plant parts, or uprooting.

Types of Effects From Mechanical Treatment

Generally, the impacts of mechanical treatments include direct mortality or damage to individual plants, the introduction or spread of non-native plants, and trampling or burial of plants. Mowing occasionally kills plants, but also can stimulate growth of grasses. Adverse impacts could occur if the mowing stimulated growth or spread of invasive non-native plant species. Piles of cut vegetation may be burned following hand thinning. Impacts associated with pile burning include soil disturbance associated with dragging materials to each pile; localized, intense burn effects upon surface fuels, litter and duff, and soil layers; and long lasting effects on soil chemistry and structure due to extreme heating over long time periods. Pile burning can result in extremely hot temperatures in localized areas, which can kill aboveground vegetation, roots, and seeds in the soil. These superheated areas also may be subject to invasion by non-native plant species.

Figure 17. Vegetation in Tomales Point FMU

Figure 18. Vegetation in the Headlands FMU

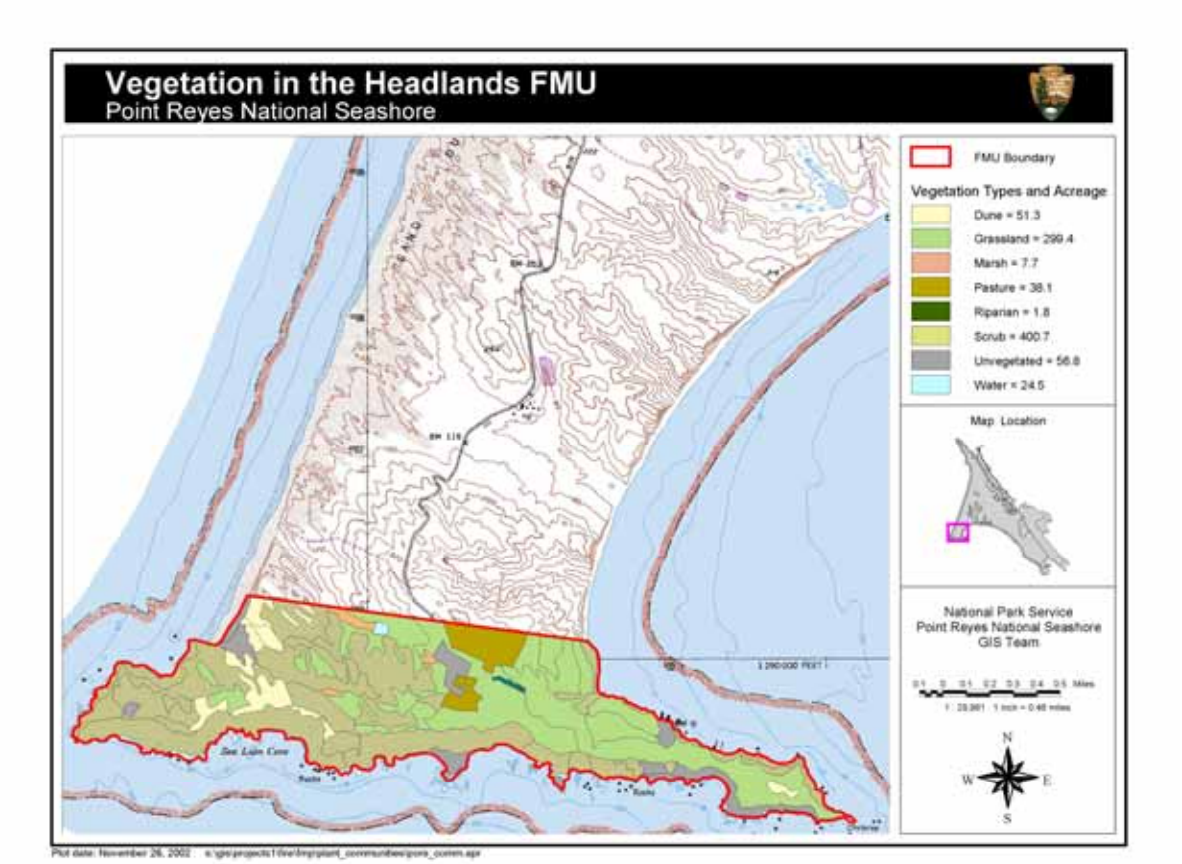


Figure 19. Vegetation in the Estero FMU

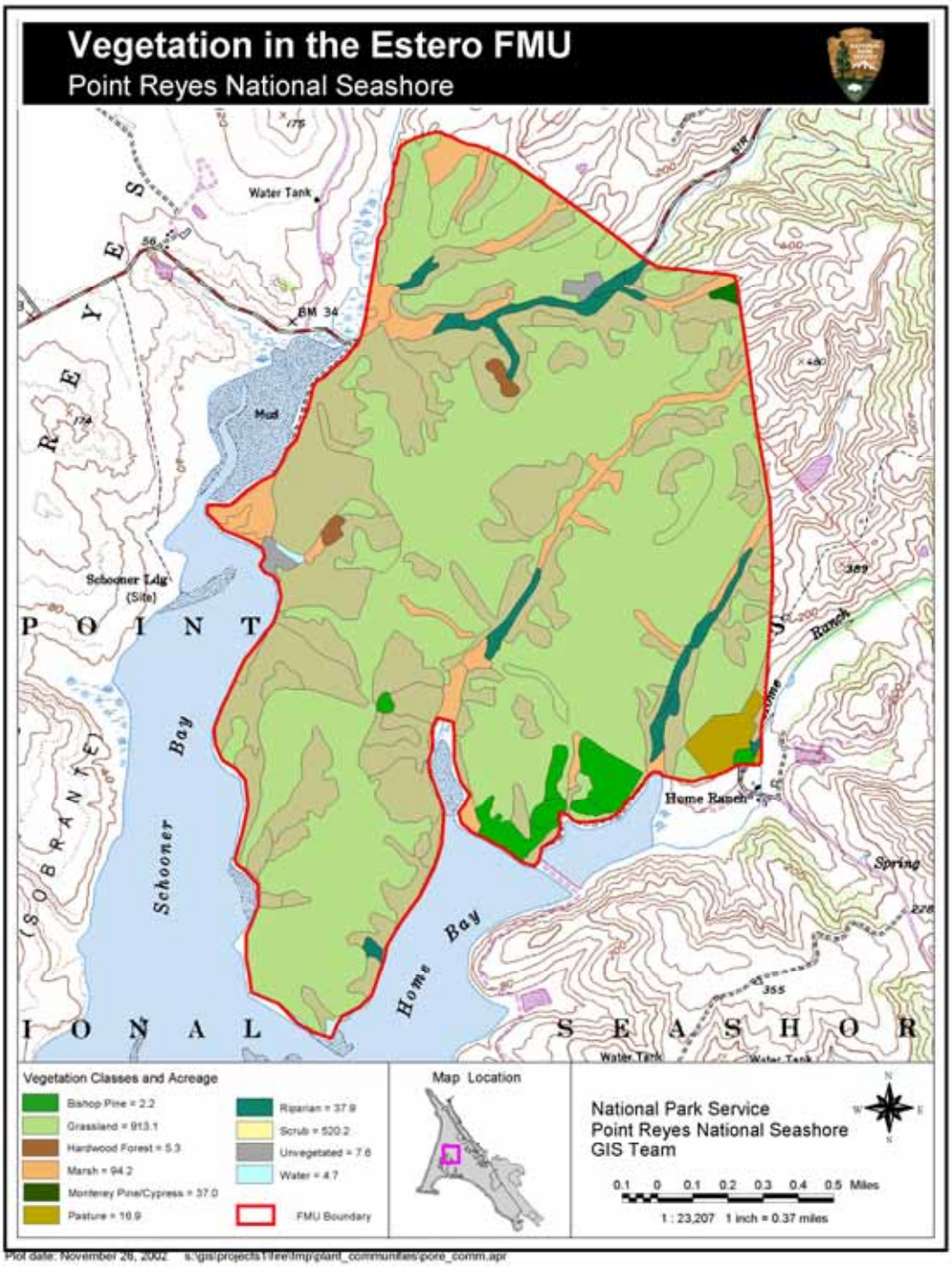


Figure 20. Vegetation in Inverness Ridge FMU

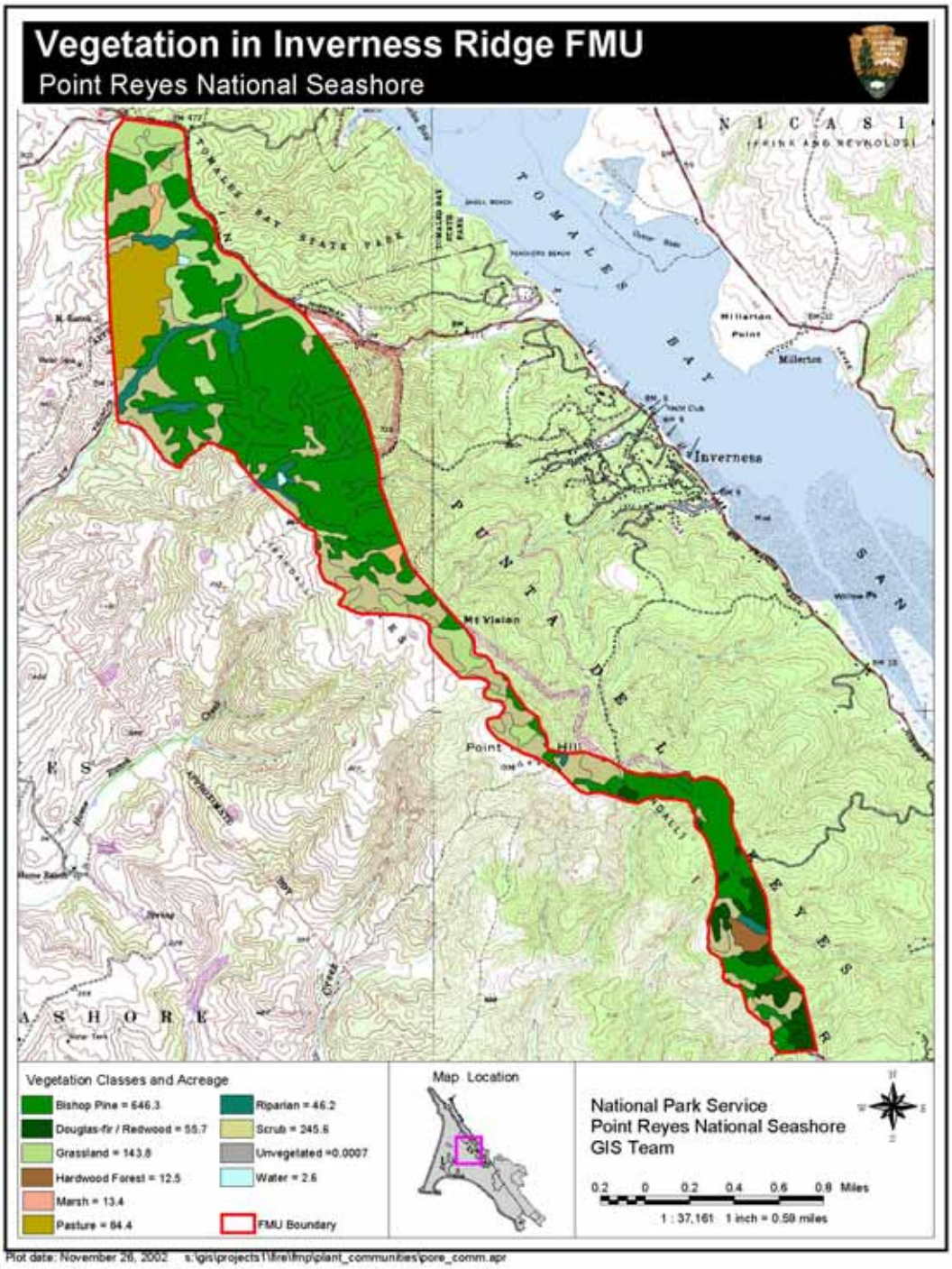


Figure 21. Vegetation in the Limantour Road FMU

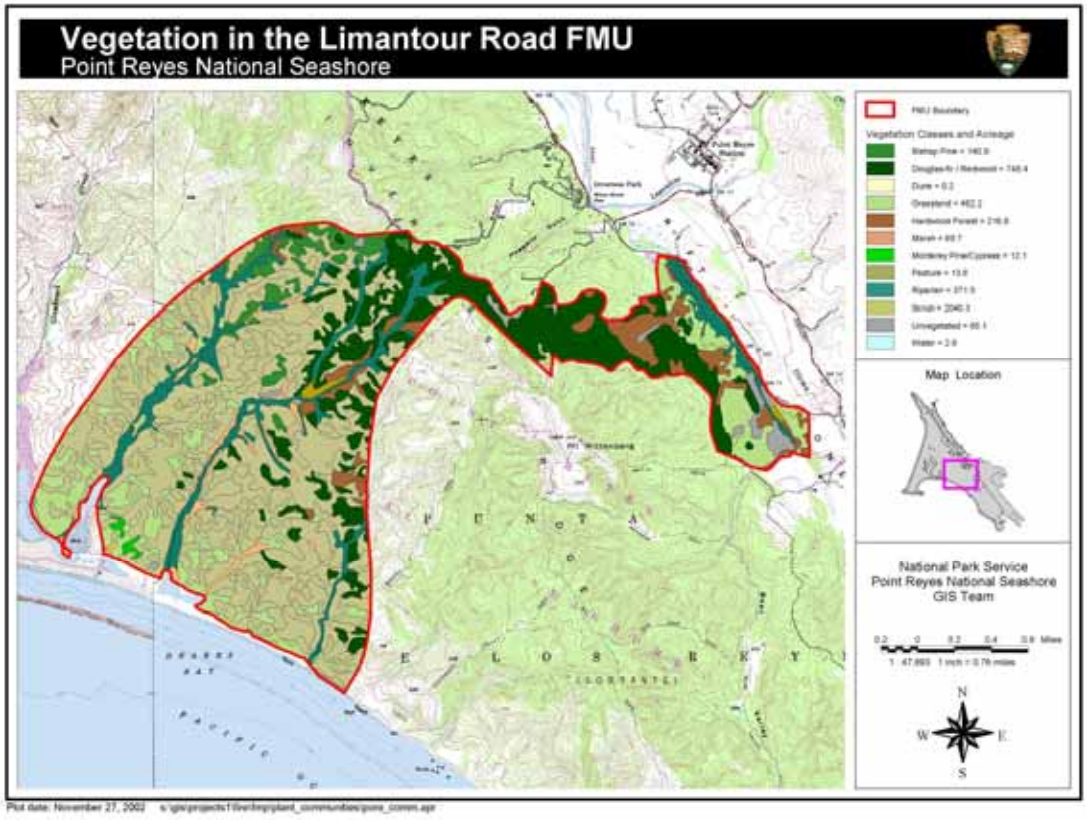


Figure 22. Vegetation in Wilderness North FMU

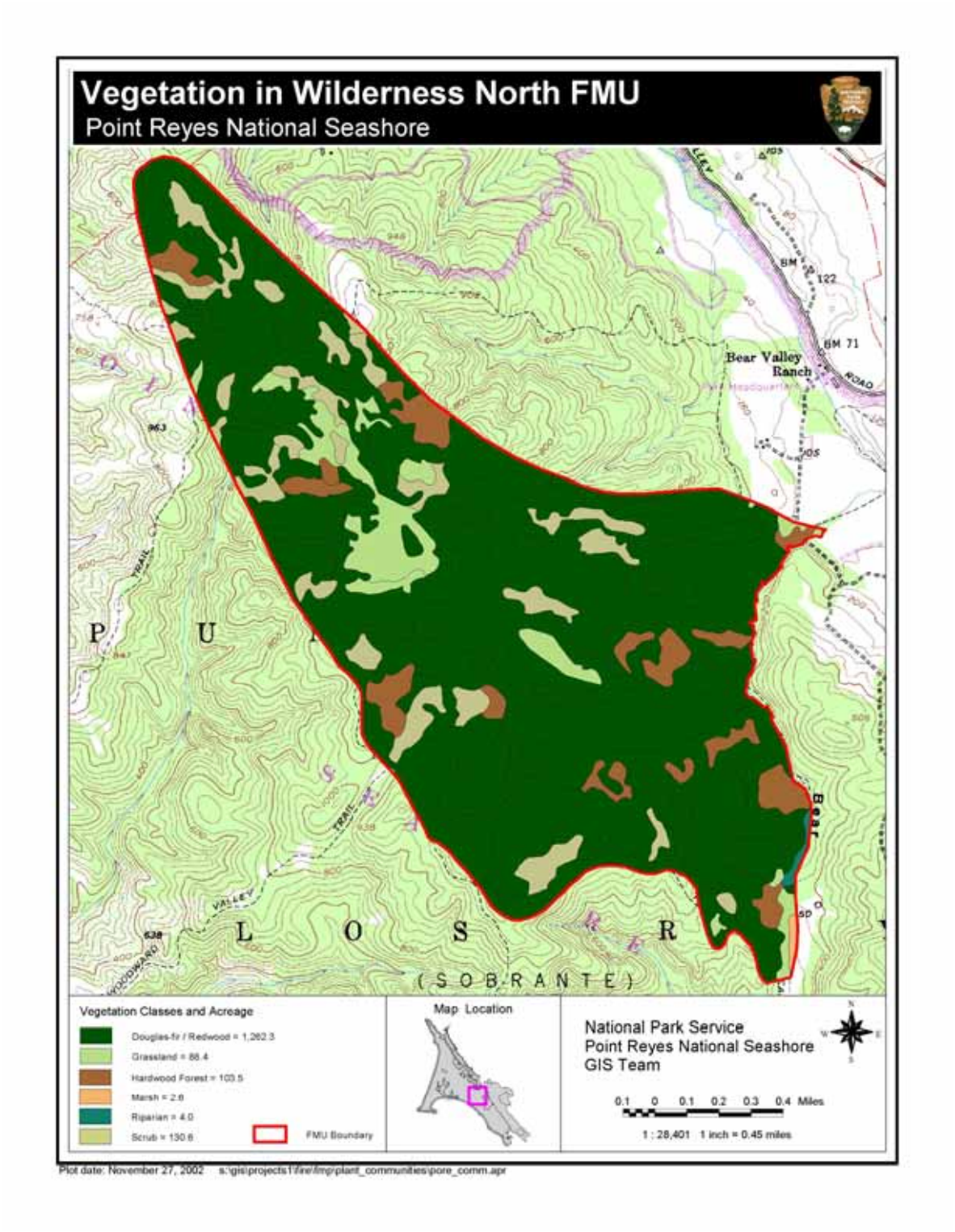


Figure 23. Vegetation in Wilderness South FMU

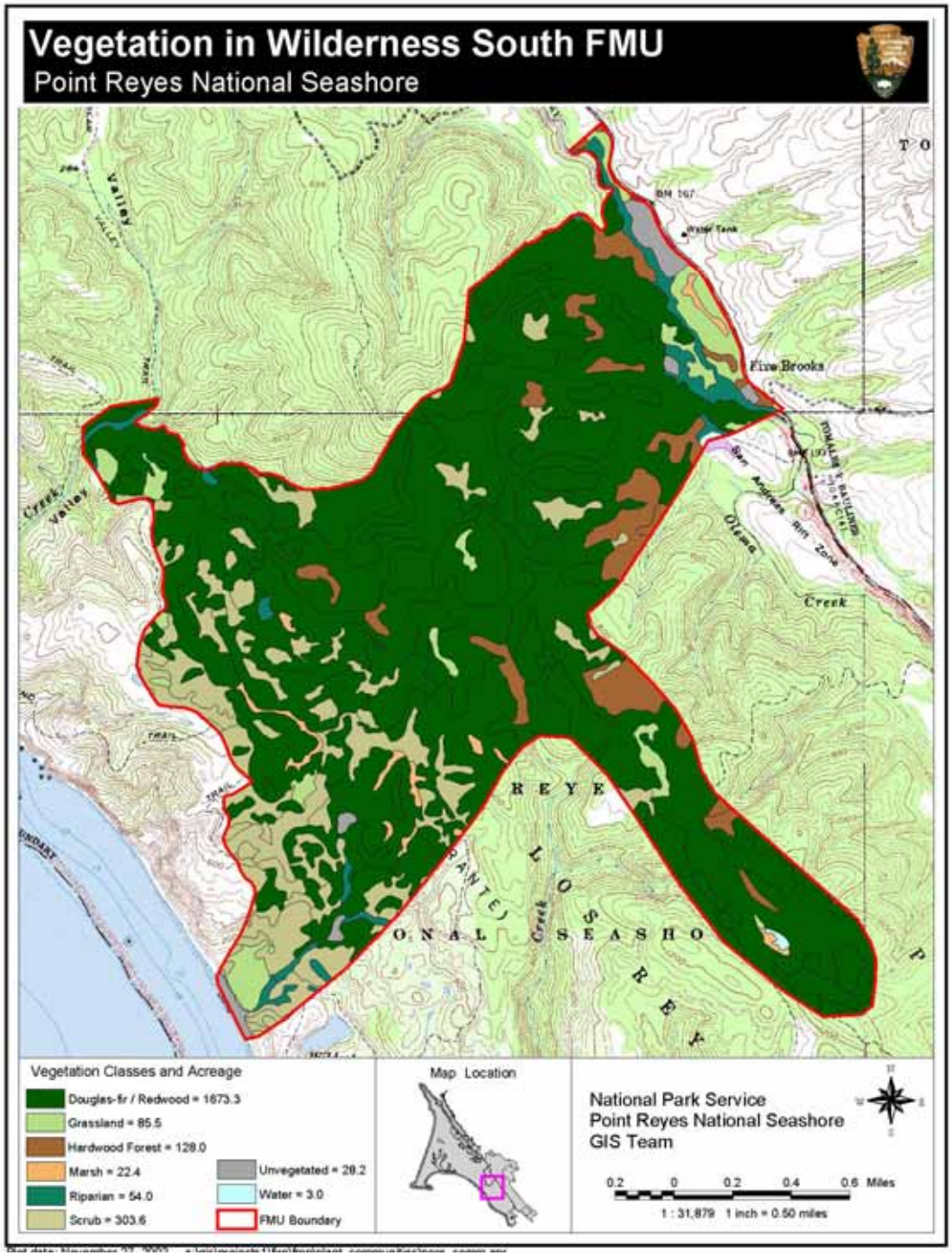


Figure 24. Vegetation in Highway One FMU

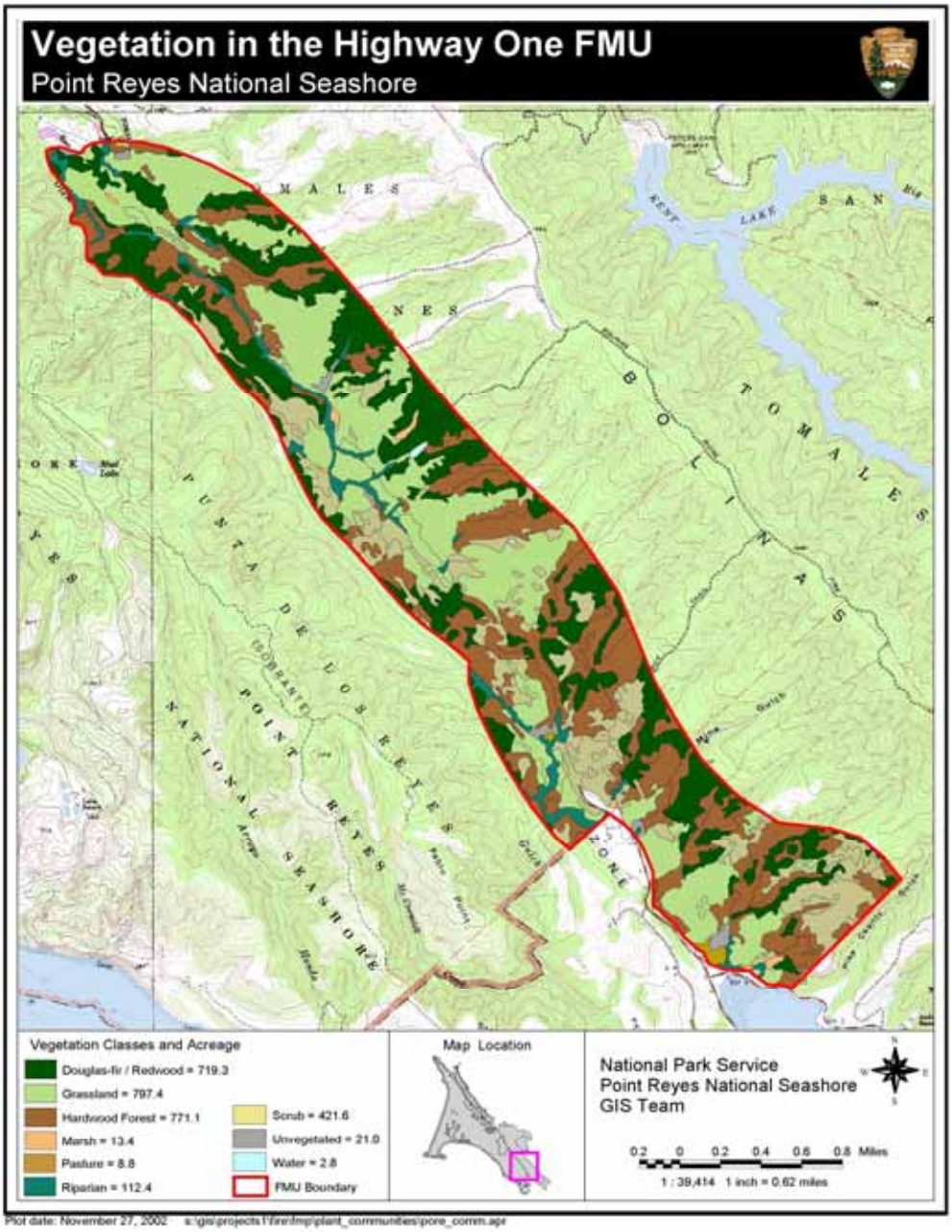


Figure 25. Vegetation in Bolinas Ridge FMU

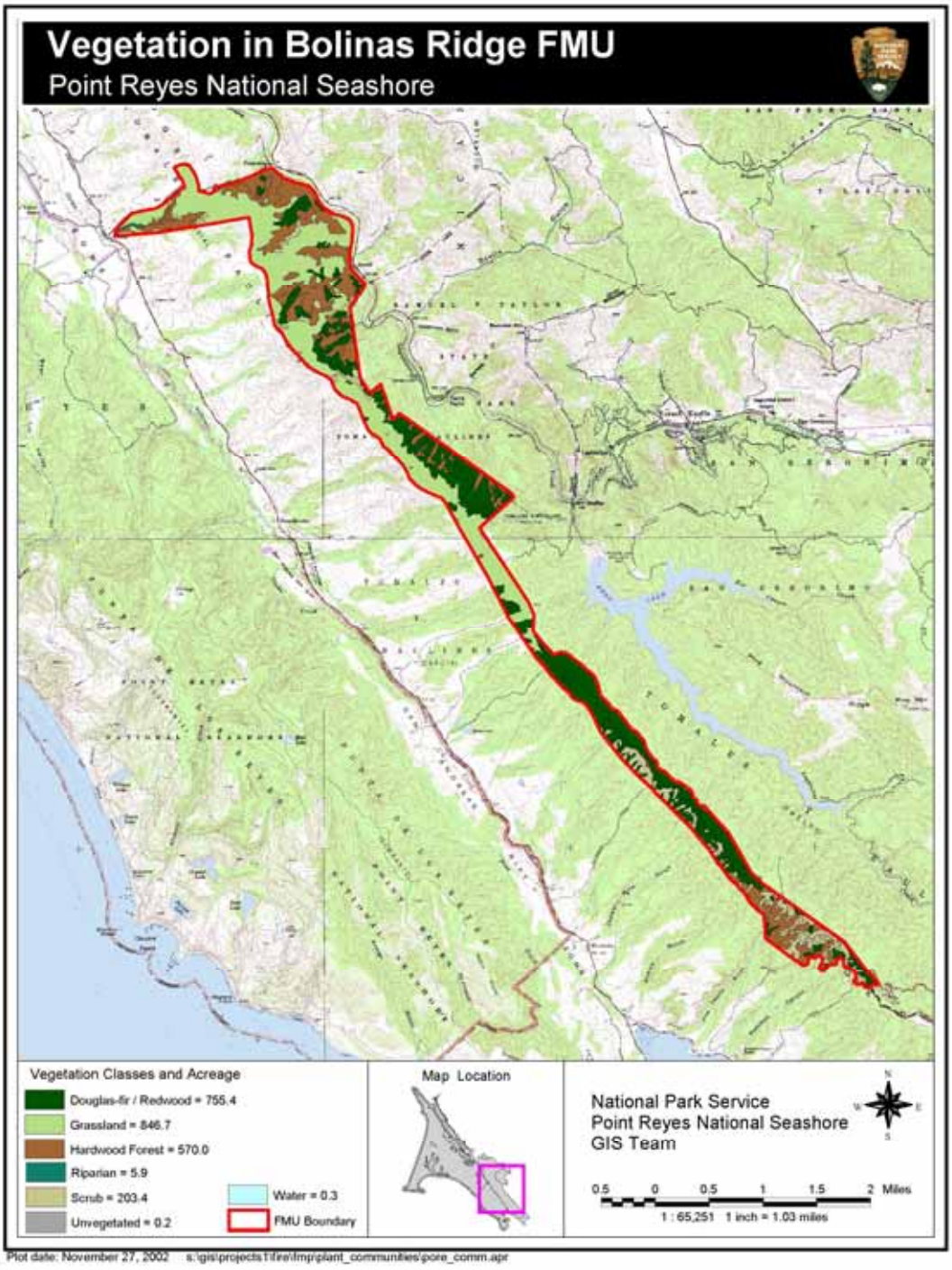
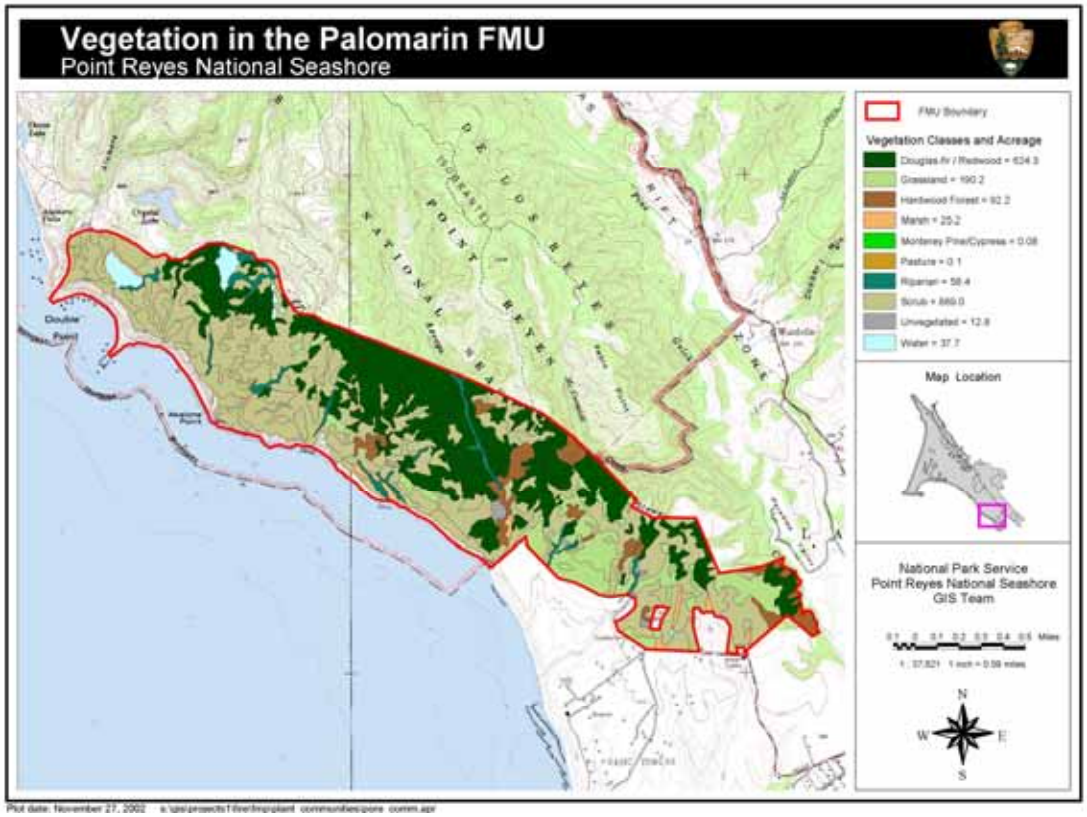


Figure 26. Vegetation in the Palomarin FMU



Alternative A

Analysis

Prescribed Fire

The FMUs that would be treated with prescribed fire in this alternative include Estero, Limantour Road, Highway One, and Bolinas Ridge. As noted in the Alternatives section of this EIS, the primary focus of treatment would be to manage hazardous fuels along primary roads and reduce the aerial extent and density of non-native invasive plant species, including Scotch broom, French broom, and Monterey pine. The impact analysis for fire management activities and cumulative impacts is discussed by vegetation type to follow the subsections of Affected Environment.

Bishop Pine Forest
Although Bishop pine forest occurs in Limantour Road FMU, it would not be treated with prescribed fire in this alternative.

Douglas-fir/Coast Redwood Forest
This vegetation type occurs in three of four FMUs slated for treatment in Alternative A, but because of the more narrow focus and fewer acres treated, would not be burned with prescribed fire.

Hardwood Forest
Hardwood forests occur in all FMUs except Headlands and would, therefore, be affected by fire management activities in all Alternatives. Limited prescribed burning could be conducted in small areas supporting hardwood forest in Alternative A, but this would occur only where such forest borders grasslands, Scotch or French broom stands, Monterey pine stands, or research plots as described in the Alternatives section of this document. Therefore the analysis of fire effects on species dominant in hardwood forests is covered under Alternatives B and C, where fire would be used to reduce fuels in this vegetation type. Prescribed burning may have negligible beneficial long-term impacts to these forests resulting from improved forest health.

Monterey Pine/Monterey Cypress
These trees occur as stands and as individuals throughout the Seashore. Although severe surface or crown fires only kill Monterey pine adults, young trees are thin-barked and can be killed with prescribed burning. Monterey pine cones are serotinous; seeds are released when cones are exposed to heat such as fire or high air temperature. Fire is particularly effective for opening cones and releasing seeds and it creates a favorable seedbed. Reproduction rates are greatest after surface fire in which the parent trees survive. In this alternative, the density and extent of stands of Monterey pine in Estero and Limantour Road FMUs would be managed in part through controlled burning. Prescriptions would be carefully controlled to kill young trees without creating conditions under which reproduction rates for remaining adults would increase.

Monterey pine and Monterey cypress were introduced into the project area as ornamentals and to provide windbreaks. Because the NPS seeks to eliminate non-native species and restore vegetation communities to a natural state, removal of individual trees in Estero and Limantour Road would have a localized minor to moderate long-term beneficial impact to native vegetation. For these beneficial impacts to persist, however, follow-up activities must be conducted to remove new recruits that come into the site in years following prescribed burning or mechanical treatments. Adverse, minor, short- to long-term impacts also could occur as a result of application of fire management activities if other non-native invasive plant species invade or spread on treated sites.

Mitigation Measures

Follow-up non-native plant monitoring and removal would be conducted to remove new recruits that come into the site in years following prescribed burning or mechanical treatments.

Riparian Woodland

Riparian vegetation occurs alongside rivers, streams, and creeks. In Point Reyes, riparian woodlands and shrublands would not be treated with either prescribed fire or mechanical means, and a 100-foot buffer would be maintained if fire management activities were to occur in the vicinity. Riparian vegetation could be burned by wildfires and potential impacts are discussed in Cumulative impacts below.

Coastal Scrub

Prescribed fire would be used to continue efforts to reduce the extent and density of non-native invasive plants Scotch broom and French broom, which are common inhabitants of both grasslands and coastal scrub (see Table 50). Prescribed fire would be used in both Estero and Highway One to control this invasive species.

Table 50. Broom Acreage within Fire Management Units

Fire Management Unit	Alternative A	Alternative B	Alternative C
Tomales Point Headlands Estero Inverness Ridge Limantour Road Wilderness North Wilderness South	1,436	1,436	1,436
Highway One Bolinas Ridge Palomarin	988	988	988
Totals	**2,424**	**2,424**	**2,424**

Earlier work reported in the park's 1993 Fire Management Plan (PRNS, 1993) indicated the temperature attained during a prescribed burn was important in killing seeds of both species of broom. Heat greater than 150 degrees C for more than two minutes killed the majority of the Scotch broom seed and those greater than 100 degrees C for one minute increased susceptibility of this species to fungal pathogens. However, temperatures of less than 65 degrees C for two

minutes significantly increased germination. French broom seeds are killed when soil temperatures reach 125 degrees C for one minute. Effective control appears to involve a combination of cutting at the end of the dry season to decrease the rate of resprouting, and a fall or spring burn repeated every year for several years. This is the approach the park has been using for Scotch broom. Preliminary monitoring has indicated the combination of cutting or mowing followed by prescribed burning has reduced the extent of Scotch broom shrubs on average by 84% since 1990 (PRNS, 2002a), a potential moderate benefit if applied throughout the range of this species. Fire management activities have not been as successful with French broom, as preliminary monitoring indicates what may be an increase in the frequency of this species in plots that have been mechanical treated and then burned. However, unlike Scotch broom, treatment regimes for French broom have been inconsistent across study plots and data do not reveal a statistically significant trend. Graphing the existing data show mechanical treatment followed by prescribed fire may be an effective means of exhausting the seed bank, although it remains to be seen if subsequent burns would reduce shrub frequencies to levels where mechanical removal of individual remaining shrubs would be feasible (PRNS, 2002a). Based on the information PRNS has to date, overall treatments would have a long-term moderate beneficial effect on vegetation.

Grassland

Prescribed burns and mechanical treatments would occur in grasslands in four FMUs under Alternative A. Treatments would occur primarily along road edges, and around structures to reduce fire hazard. Impacts of these activities on vegetation are expected to be adverse, negligible to minor, and short- to long-term if non-native species expand in density or aerial extent as a result of treatments.

Dominant non-native plant species in grasslands in the project area include velvet grass, annual wild rye, perennial ryegrass, small fescue, foxtail fescue, and Farmer's foxtail. Dominant native grass species include tufted hairgrass, California brome, Pacific reedgrass, California oatgrass, and meadow barley. Monitoring results and other, published, information indicate annual wild rye adults are likely killed by fire, although their seeds may survive. The remainder of the dominant non-native species of grasses at the Seashore either are largely undamaged by prescribed fire, or appear to be stimulated by it. This is because seeds are either buried and unaffected by all but very hot fires, or the plant sprouts from buried structures, such as rhizomes or root crown in the growing season following the burn. As noted in Affected Environment, roughly 80% of the grasslands at the Seashore are dominated by non-native grass species.

In keeping with NPS and Seashore objectives to reduce the aerial extent of non-native species and encourage natives, prescribed fire has been used in combination with mowing, grazing, seeding, and/or herbicides with varying degrees of success to try to shift the balance. A recent meta-analysis (Twedt, 2003) of such attempts did not identify any strategy that consistently favored native species relative to non-native species. Rather, the outcomes were very case- and site-specific. For example, while a combination of prescribed fire and mowing has been successful in removing scotch broom from some grassland communities, prescribed burning of the high invasive purple velvet grass may be increasing its abundance.

The results of monitoring more than a decade of fire management efforts at the park remain preliminary, and additional control plots and data need to be gathered before a particular management approach for each vegetation type can be linked to a conclusive result; however these initial results show prescribed burning can result in an increase in non-native species as easily as a decrease. As part of this plan (and as noted in Mitigation sections), the effects of all prescribed burning carried out on grasslands would be carefully monitored to assess post-burn plant species cover and composition. If monitoring shows prescribed burning is definitively linked to an increase in non-native plant cover or distribution, either the prescription would change (e.g., burn during different seasons), it would be combined with other treatments (such as mowing, seeding of natives, etc.), or another strategy would be employed to restore native grassland vegetation.

Mitigation Measures

All grassland burns would be carefully monitored to ensure burn objectives (= recruitment and long-term maintenance of native species without introduction of invasive non-native plant species) are being met.

To enhance grassland plant species composition, and reduce the chance of invasion or spread of non-native species, native seeding trials would be conducted following fire management treatments in some areas.

Pasture

The majority of pasture is within the Minimum Management Unit, and is used to graze cattle or horses or managed to produce silage for cattle. In the FMUs slated for treatment with prescribed fire in this alternative, all but Bolinas Ridge have small amounts of pasture. In general, no fire management activities are planned for these areas, except clearing of vegetation around structures and clearing along roads and fire roads. However, small areas of non-native species, including Scotch broom, French broom, or Monterey pine in pasture vegetation may be burned or mowed to reduce the density and aerial extent of these invasive species. Impacts associated with these efforts would be beneficial, minor to moderate, and long-term as a result of removal of invasive non-native plants. For these beneficial impacts to persist, however, follow-up activities must be conducted to remove new recruits that come into the sites in years following prescribed burning or mechanical treatments. Because results vary when prescribed fire is used to treat non-native invasive species, some unexpected spread of a particular population may also occur. If so, this would result in adverse, minor, short- to long-term impacts.

Coastal Dune

No coastal dune vegetation occurs in the FMUs that would be treated with prescribed fire in this alternative.

Unplanned Ignitions, Wildland Fire, and Suppression

The average number of unplanned ignitions at Point Reyes has been three fires annually, with each of these fires burning less than ten acres. The actual extent and magnitude of impacts are impossible to predict, however, as these fires are unplanned. Information on direct effects would, in most cases, be obtained after the fire, and would involve documenting effects on

resources for which little pre-burn data were available. All of these impacts would be mitigated following a fire with assistance from the NPS Burned Area Emergency Rehabilitation (BAER) program.

The impacts on vegetation associated with these small, unplanned wildfires and their suppression are expected to be both adverse and beneficial. Adverse impacts are expected to be minor and short-term, and result from the loss of individuals of native species through mortality or decreases in reproductive ability. It is possible that small invasions of non-native plants would result from these fires, which could result in a longer-term impact, but the impact would be localized. Small unplanned wildland fires in the project area may have some beneficial impact on vegetation in localized areas if non-native plants are killed, and native plants establish on the site following the fire.

Suppression activities would also have direct but localized impacts. Fire control lines involve clearing all vegetation within an 18 to 24 inch-wide swath down to bare mineral soil. In grassland habitat, a weed whacker, mower, or tractor may be used. In shrub or forested habitats the vegetation is cut and the fireline is cleared using chainsaws, shovels, Pulaskis, and McLeods. Fire line construction also can include cutting brush, limbing trees, and cutting snags. Inward 10 to 20 feet from the fire's perimeter line, vegetation density (and consequently fire intensity) is reduced by cutting down all trees and cutting shrubs to a 15 to 20-foot wide separation using chainsaws, shovels, Pulaskis, and McLeods. In emergency situations, bulldozers are used to create fuel breaks to stop wildfire. Vegetation clearing can create conditions that are favorable for the establishment of non-native plant species.

Aerial drops of water or retardant release liquids onto burning or unburned areas. Vegetation can be physically damaged from the impact of the liquid, but the areas affected tend to be small and the effects relatively local. Although the chemical components of retardant only remain for a few months at most, and long-term, chemical alteration of the soil would not occur, there could be localized long-term impacts to areas if non-native plants become established or spread.

Fire suppression activities may require development and use of helispots and spike camps, which could disturb vegetation. In forested areas, trees and/or snags may be removed to open areas for safe operation of aircraft or to make camps safe for fire personnel. These impacts generally are local. Aircraft skids or wheels, boots, equipment, and camp and base supplies could be contaminated with non-native seed, providing vectors for non-native species that would not otherwise disperse to these sites.

Post-suppression mop-up involves digging, cutting, trenching (to prevent debris from rolling), chinking (taking a pulaski and clearing burning material off a log), chunking (putting smoldering material into one pile and letting it burn up), and mixing dirt with water from backpack pumps or from hoses. Any smoldering that is causing nuisance smoke is extinguished.

Mitigation Measures

Adverse impacts to vegetation would be mitigated to the greatest extent possible during all fire management activities using the following measures:

Pre-Treatment Measures

Individual prescribed burns would be conducted within the framework of a multidisciplinary planning effort. Personnel from fire management and from resources management would work together to identify areas that are expected to benefit from prescribed burning. Existing data on the response of plant communities in the Seashore to fire would be consolidated and analyzed to determine optimal areas, configurations, and times for burns. Clear objectives would be developed for prescribed burns that would include measurable parameters to determine the effects of the burns on vegetation. Following burns, vegetation would be analyzed to determine the effects of the burn, which would aid in future burn planning.

Impacts associated with all fire management treatments would be minimized through pre-project planning and coordination with vegetation managers within the Resource Management Division.

Prescribed burns would be conducted at a time of year when introduction or spread of non-native plants would be minimized, and mortality of non-native plant species would be maximized.

Whenever possible, existing roads or trails would be used as firebreaks for prescribed burns and for wildland fire suppression.

Prescribed burns would be planned to minimize adverse impacts to vegetation to the greatest extent possible (e.g., in areas supporting invasive non-native plants, spring burns may be less likely to result in spread of the non-natives and should be considered; in these cases, however, other factors also must be considered such as whether or not spring burning would adversely affect soil seed of native plant species).

Vegetation managers would work with fire management staff to develop maps of areas that support plant communities of special management concern (e.g., uncommon communities, wetlands, riparian areas, dunes, areas with no non-native plants that need to be kept intact, areas with highly invasive non-native plants that should not be spread) so fire personnel can attempt to avoid such areas when making decisions about fire management tactics.

During Treatment Measures

Soil disturbance would be minimized to the greatest extent possible to reduce potential for introduction or spread of invasive non-native plant species.

The aerial extent of disturbance associated with mechanical treatments would be kept to the minimum necessary to reduce fire risk.

Known populations of special-status plant species would be avoided when locating helispots or spike camps.

Previously disturbed sites and open areas would be used for helispots or spike camps whenever possible to minimize additional disturbance.

Burn piles would be kept small to minimize the area disturbed and to allow for the recolonization of sterilized patches by mycorrhizal fungi and other soil organisms in adjacent areas.

Post-Treatment Measures

Areas subject to fire management treatments would be monitored periodically for the presence of invasive non-native plant species, and if such species have established or spread as a result of such activities, the non-natives would be removed.

All fireline (both handline and dozer line) would be rehabilitated as quickly as possible, which includes application of Burned Area Emergency Rehabilitation (BAER) techniques such as recontouring, soil stabilization as needed, and monitoring for and removal of invasive non-native plant species for a minimum of three years following a fire.

Litter and duff would be replaced on disturbed sites to make them less susceptible to invasion by non-native species.

Post-treatment surveys for non-native plants would be conducted in areas subject to mechanical treatments, and measures to remove non-native species in disturbed areas would be undertaken.

Mechanical Treatment

Up to 500 acres of vegetation would be mechanically treated in Estero, Limantour Road, and Highway One FMUs in Alternative A. The focus of treatment would be mowing grasslands to reduce hazardous fuels and control Scotch and French broom, and cutting Monterey pine to help eliminate this non-native species.

Vegetation would be mowed around structures and along roads to reduce fire hazard, and, in some cases, around the perimeter of a planned prescribed burn to contain the burn. Mowing occasionally kills plants, but also can stimulates growth of grasses. Adverse impacts could occur if the mowing stimulated growth or spread of invasive non-native plant species. Mowing has been used to some degree of success in helping control the spread of scotch broom (see coastal scrub, below). This would continue in Alternative A.

In the past, cutting and thinning of vegetation has been conducted in small, developed areas of the Seashore, primarily around structures and along roads. Under this alternative, thinning would continue in these areas to remove small diameter trees and brush to reduce the risk of unplanned ignitions, to safeguard structures, and to make travel on roadways safer in the event of an unplanned wildfire. Some soil disturbance would occur during this work and there would be a potential for non-native plant species establishment or spread. The minimum requirement for defensible space along roadways is 10 feet on each side.

For clearing along roads, trees along the sides of the roadways are limbed up to 10 feet in height as needed. Native tree species commonly subject to limbing include Douglas-fir and Bishop pine. Trees less than four inches in diameter (dbh) are removed from a corridor 10 - 15 feet wide

on each side of the road (measured from the edge of the roadway). This width can increase to 20 feet wide where roads cross topographic saddles. Downed trees in or near the roads are cleared. Grass growing up within roads is cut or mowed.

Defensible space required at each structure is based on individual site topography, and usually ranges from 30 - 50 feet around structures. In some cases, a larger cleared area may be required to protect the structure from potential fire hazard due to prevailing winds or the presence of drainages or swales close to the structure. For defensible space large trees are pruned or removed if the tree poses a threat, grasses are cut to stubble, and smaller trees are pruned or removed based on individual site topography. The health of all trees within the defensible space is assessed and any dead and dying trees are removed.

Piles of cut vegetation may be burned following hand thinning. Impacts associated with pile burning include soil disturbance associated with dragging materials to each pile; localized, intense burn effects upon surface fuels, litter and duff, and soil layers; and long lasting effects on soil chemistry and structure due to extreme heating over long time periods. Pile burning can result in extremely hot temperatures in localized areas, which can kill aboveground vegetation, roots, and seeds in the soil. These superheated areas also may be subject to invasion by non-native plant species.

Bishop pine, Douglas-fir, and Hardwood forests
Under Alternative A, impacts from mechanical treatment to forest vegetation, including bishop pine, Douglas-fir, and hardwood forests, would come from the thinning and fuel reduction activities described above. These impacts would be adverse, negligible to minor, and short-term (potentially long-term if non-natives are introduced or spread).

Monterey Pine/Monterey Cypress
Monterey pine and Monterey cypress were introduced into the project area as ornamentals and to provide windbreaks. Because the NPS seeks to eliminate non-native species and restore vegetation communities to a natural state, removal of individual Monterey pine trees in Estero and Limantour Road would have a localized minor to moderate long-term beneficial impact to native vegetation. For these beneficial impacts to persist, however, follow-up activities must be conducted to remove new recruits that come into the site in years following mechanical treatments.

Mitigation Measures

Follow-up non-native plant monitoring and removal would be conducted to remove new recruits that come into the site in years following prescribed burning or mechanical treatments.

Riparian Woodland
No mechanical treatment would occur in riparian woodland in any alternative.

Coastal Scrub
Under Alternative A, mechanical means would be used in coastal scrub in areas that require treatment around structures or along roads or fire roads. Adverse negligible to minor short-term

impacts could result. In addition, mowing to target both Scotch and French broom in Limantour and Highway One FMUs would continue (see discussion of prescribed burning in coastal scrub above), with possible moderate benefits to native coastal scrub species.

Grassland
Scotch and French broom also occur in grasslands in the above mentioned FMUs, where mechanical treatment by mowing would be used to help control the spread of these species.

Pasture
As noted above, treatment would generally not occur in pasture, although some mowing of Scotch and French broom is possible.

Coastal Dune
No coastal dune vegetation occurs in the FMUs that would be mechanically treated in this alternative.

Fire Information/Education

This would have no beneficial or adverse effects on vegetation.

Fire Cache/Park Headquarters Relocation and Construction

The construction of a fire cache at Bear Valley would not have a beneficial or negative impact on vegetation. The building would be located at least 100 feet from riparian zones and temporary construction plastic fencing would be used to eliminate any impacts to this vegetation zone. In addition, the site is a former trailer pad and nearly unvegetated.

Fire Effects and Fuel Management Research

Research burns would continue on velvet grass and Scotch and French broom to help Seashore ecologists refine burning prescription parameters to control these species. This could have substantial benefits to the park's natural coastal scrub and grassland communities in Estero and Highway One FMUs, as well as to these communities both within the entire study area and in the region where these species are currently invading. Alternative A does not include any research or test plots in other vegetation communities, or to test other factors in grasslands and coastal scrub. To the extent that no additional research is conducted, fire-dependent native vegetation would continue to decline.

Cumulative Impacts

Perhaps primary among the combination of factors influencing vegetation at Point Reyes is the century of fire suppression beginning in the late 1800s. Evidence from tree rings show periodic fire (ranging from every 6 to perhaps as long as 30 years) in the project area is a natural occurrence, and several native species in the project area reproduce abundantly only following fire. Suppression of periodic fire has favored fire-intolerant species, non-native species and allowed the unnatural buildup of both dead and live fuels. Shrub and grassland habitats for

example, are experiencing encroachment by fire intolerant conifers. Native Marin manzanita populations are becoming rare as a result of shading from increasing forest stand density. As noted in other locations in this EIS (see Fire History, for example) the build up of fuels, or change from understory (grasses and forbs) dominance to overstory (trees and shrubs) dominance, and changes in forest structure generally increases the risk of a large-scale wildfire, which can affect vegetation in the extreme by completing replacing existing vegetation (Covington et al., 1994). In some cases, replaced vegetation would not return; in others, a climax seral stage may return after many years.

Logging, grazing and development of land in the region have also contributed to changes in composition and density of key species. For example redwood forest is estimated to have covered 1,976, 000 acres.150 years ago. Today, approximately 1,570,000 acres is left, and only 11% of that is protected park land (Jensen, 1993). Analysis of pollen from coast live oak (the dominant tree of the park's hardwood forests) show that oak woodlands were stable for up to four centuries before major European-American settlement. Fire suppression efforts beginning in 1870 and extending into recent years resulted in a two-fold increase in oak pollen and oak density. Today, recruitment of most oaks in California has declined, with some species not regenerating rapidly enough to maintain current density (Jensen, 1993). Monterey pine, Monterey cypress, and eucalyptus have all been imported by European-American settlers for lumber or other reasons. Eucalyptus in particular has been a prolific "weed tree" over much of California. Coastal sage scrub is present in about 15% of its former habitat, primarily because of agricultural, industrial, and residential development. Grasslands in California have been invaded by exotic species in part because of the displacement of native elk by domestic livestock, the introduction of exotic plant species adapted to livestock grazing and the clearing and plowing of land for agriculture (PRNS, 1993). Scotch and French broom are escaped ornamental shrubs brought from Europe and velvet grass is imported from Eurasia. All are highly invasive species that occur in grasslands and coastal scrub in the study area. In the immediate study area, the projects cited in Appendix C have removed some vegetation, and park needs may continue to result in minor impacts to vegetation from removal, or from disturbance that allows non-native invasive species to take hold in some localized areas.

Fuel build-up from a century of fire suppression increases the potential that a large crown fire could occur. In Alternative A, the treatment of 500 acres through mechanical means or prescribed fire would do little to reduce the risk of such a fire. These larger fires could result in establishment and spread of non-native plants, or habitat type conversion. Activities to suppress large wildland fires would be the same as those described above in the Unplanned Ignitions section and could have substantial, although localized, impacts on vegetation if extensive areas are treated with retardant, or if extensive dozerline is constructed. The actual extent and magnitude of impacts are impossible to predict, as these fires are unplanned. However, a large-scale fire similar to the Vision Fire could have major adverse and potentially long-term effects on some native park vegetation communities. In others, such as Bishop pine, wildfires may actually stimulate reproduction and increase density, with resulting long-term positive impacts.

Bishop pine

Fire plays an important ecological role in maintaining Bishop pine forests. Stands of Bishop pine are characteristically even-aged, originating after fires, and their cones persist for many

years, usually opening as a result of fire. Bishop pine stands are often dense, and stand-replacing crown fire typically occurs in such stands.

A recent vegetation mapping project, conducted from 1996 through 2001, revealed approximately 3,570 acres of Bishop pine forest occurring within Seashore boundaries. In 1995, approximately 35% (1,250 acres) of this acreage was burned in the Vision Fire. Following the fire, most of the pines in the area were dead and the formerly deep litter layer had been burned away. The bare, charred soil was covered with extremely large numbers of Bishop pine seeds. Regeneration in the burned area has been prolific, with dense stands of young Bishop pine growing up to replace the burned forests. One year following the fire, large dense patches of Bishop pine had recolonized the burned area. This suggests that the increased risk of a crown fire at the Seashore would have a relatively beneficial impact on bishop pine forest.

Douglas-fir/coast redwood forests
In some areas supporting Douglas-fir forest in the Seashore, fuel loads have increased as a result of fire suppression. Vertical separation between surface fuels and the conifer overstory has been eliminated or substantially reduced by the growth and development of a midstory conifer layer. In many areas, duff layers and woody debris have increased while the biomass of the ground vegetation layer has decreased. This increases the potential for crown fire.

Seedling establishment following fire depends on the spacing and number of surviving seed trees. Seedling establishment in stand-destroying fires is slow because seed trees are killed over large areas. Where seed trees are scarce, it may take 100 years or more for Douglas-fir to reoccupy the burned area. Conversely, Douglas-fir can quickly establish seedlings if there are numerous, well-spaced surviving seed trees within the burned area. Mineral soils exposed by fire are generally considered favorable seedbeds.

Hardwood Forest
Both of the dominant species of park hardwood forests, California bay and Coast live oak, are able to survive and/or repopulate following most wildfires. While bay is not protected from even moderately severe fires by virtue of its thin bark, it does resprout from the root crown or bole following fires, a characteristic typical of most California hardwoods. Sprouting in California bay occurs after fire in virtually any season, and reproductive ability is regained quickly; flowers have been noted on first-year sprouts. Seedlings are established the first year, and California bay continues to produce seedlings until the next fire. In the coast redwood forest of Muir Woods National Monument, for example, 567 seedlings per acre were observed at postfire year 134. The dense understory was co dominated by redwood and California bay trees that began as sprouts and seedlings following the 1845 fire.

Adult coast live oaks are more protected from wildfires than California bay. They are evergreens, have thick bark, have roots that are protected from fire by an outer corky layer, and generally recover well from fire. Evergreen leaves allow this species to allocate greater amounts of energy to recovery from fire than to replacing the entire crown annually. Evergreens are often better able to conserve nutrients than deciduous species, and are favored in fire-prone environments.

Coast live oaks sprout from the main trunk and upper crown even after severe burning. When trees are top-killed, they sprout from the root crown. Vigorous sprouting is supported by food reserves stored in the extensive root system. Resprouting from the root crown often occurs during the first two months after being blackened by fire, but some charred trees do not resprout for 2 to 3 years. Prefire crown volume is generally recovered, or nearly so, in about 8 to 10 postfire years.

Coast live oak seedlings and saplings less than three inches in diameter may be top-killed by low- to moderate-severity fire, and severe fire kills trees of this size. Because of vascular cambium protection, mature trees have high fire survival rates, even with crown fire. Trees greater than 6 to 8 inches in diameter resist top-kill. An "extremely hot" crown fire on the San Bernardino National Forest caused only 4% coast live oak mortality. Ninety percent of the oaks less than 3 inches in diameter were top-killed, and 2% were killed. Of trees greater than 6 inches in diameter, the trunks and crowns of all but 5% survived the fire without top-kill (the 5% includes 3% that were top-killed and 2% killed). Generally mortality of coast live oak is greater when there is a considerable shrub understory or when trees are adjacent to chaparral.

Coast live oak generally recovers well from fire, although severely burned crowns, trunks, and root crowns may require several years to sprout. If sprouting occurs within several postfire months, basal sprouts can be 2 to 3 feet tall in 2 years, and crown density can be 80 to 100% of prefire levels within 10 years. The most common fire damage to the trunk is a basal wound resulting in potential cambium death. Wounds less than a few inches in size may eventually heal with no accompanying heart rot, but larger wounds are susceptible to fungal and bacterial pathogens and insect infestation.

Although it is difficult to predict the impacts of unplanned wildland fire in these forest types, such impacts could be beneficial, moderate to major, and long-term.

Monterey pine/Monterey cypress
Monterey pine and cypress adults are killed by severe surface or crown fire. Because the adults would normally be the seed source from which new trees grow, their destruction can effectively eliminate several individuals of a population. Follow-up prescribed burns or removal through mechanical means of any juveniles could mean the eventual elimination of these non-natives from the park, a long-term moderate benefit.

Riparian woodland
Red alder and willow dominate riparian woodlands in Point Reyes. Red alder is an early seral species and quickly invades forest openings, such as those created from fires. Young plants grow quickly, which gives the shade-intolerant red alder a competitive edge over conifers, such as Douglas-fir. Because it is shade intolerant, red alder trees that do not maintain their height in the canopy die, resulting in even-aged stands. After about 25 years, conifers equal red alder height and begin to overtop them, and by about 40 years, Douglas-fir becomes dominant. Few red alder trees remain in these formerly mixed stands past 60 years. As stands develop and trees mature, they prevent other red alder seedlings from becoming established, due to the seedlings' shade intolerance.

Red alder's bark, although thin, is sufficiently fire resistant to protect trees from light surface fires. The foliage and leaf litter do not carry fires well. Red alder stands often lack flammable understory debris and are often on moist sites that burn infrequently. Red alder revegetates burned areas via seed from off-site plants. Fire hazard is generally low in red alder stands and stands may be used as natural firebreaks.

Arroyo willow (*Salix lasiolepis*) resprouts from the root crown or stem base following fire. Generally, willows tend to be prolific seeders, and off-site plants are important as a seed source for revegetating burned areas. Severe fires can completely remove organic soil layers, however, leaving willow roots exposed and charred, thus eliminating basal sprouting. Severe fires probably occur infrequently in the moist habitats occupied by arroyo willow.

Both red alder and arroyo willow are highly adapted to periodic, lower intensity fires, and by virtue of their location near rivers or in moist soils are also somewhat resistant to hotter fires. However, high-severity fires in Point Ryes such as the Vision Fire are characterized by extensive burned areas that may be continuous from ridgeline to slope bottom and include riparian areas. Once the seed stock of red alder, or the root crown or seed source of arroyo and other willows is destroyed from this type of very hot and all consuming fire, reestablishment of vegetation would take several years or longer. In addition, during extreme weather events, debris torrents would potentially scour streams, delaying restoration of the riparian community for even longer. It should be noted that in the spring following the Vision Fire, a burned section of the riparian corridor had alders send out leaves, but by the end of the summer many of those trees had died. By year four following the fire nearly all of the alders burned in the fire had died and fallen. They were being followed up by new sprouts; however, the riparian corridor was far more narrow due to the incised channel. Unplanned wildland fire could have adverse, moderate to major, long-term impacts to vegetation in riparian areas if fuel accumulations are large and fires burn very hot.

Coastal scrub

Wildfires are most detrimental to coyote brush, the dominant shrub of coastal scrub, when high temperatures are present at stem bases. At lower temperatures, or if only the above ground portion of the plant is killed, it can reproduce from seed for by spouting from the root crown. Very hot ground fires, however, girdle and kill root crowns, particularly those less than 1 inch in diameter. This means a crown fire, which may be more likely in scrub where ladder fuels have built up, would leave this dominant relatively unharmed and even stimulate resprouting. A hot ground fire, however, would kill adults (McBride and Heady, 1968). A large-scale fire like the Vision Fire because it was a crown fire coastal scrub vegetation had only minor adverse impacts. Most coastal scrub habitat stimulated resprouting.

Grassland

The grassland fuel complex at Point Reyes has changed considerably since European settlement. Over much of the park, evenly spaced perennial bunchgrasses have been displaced by dense stands of annual grasses. The separation between bunch grasses traditionally kept fires to moderate intensity with low to moderate rates of spread, but the dense stands of non-native annuals burn with greater intensity and more rapid rates of spread. In addition, annual species cure rapidly with the onset of the drought in mid-April resulting in a longer fire season that that

which existed prior to European habitation (Greenlee, 1983). A large-scale wildfire in Point Reyes could result in damage to non-native species by killing rhizomes from which they sprout and seeds if soil temperatures are high enough. For example, annual wild rye (*Lolium multiflorum*) decreases on burned sites, and non-native perennial ryegrass (*Lolium perenne*) rhizomes are killed in severe fires. Other non-natives are better adapted to fire; fescues (*Vulpia spp*.) produce abundant seed and drop them early enough in the season that they avoid damage from coastal wildfires. Native dominants, such as tufted hairgrass (*Deschampsia caespitosa*) and California brome (*Bromus carinatus*) appear to able to survive all but the most severe burns and spout from root crowns following a fire. As with prescribed burning, impacts to grassland species from wildfires would likely be variable.

Pasture
Although pasture is essentially grassland, fuel loading is significantly lower because of grazing by cattle. The relative intensity of a wildfire would be lower, and species adapted to cooler ground fires would presumably benefit.

Coastal Dune
Coastal dunes are largely dominated by non-native European beachgrass and iceplant. Although these species are mechanically removed, a wildfire may be helpful in reducing the extent of these populations. The chances of wildfire reaching them are considered low, however.

Conclusion

Limited prescribed burning may have negligible beneficial long-term impacts to hardwood forests resulting from improved forest health. Removal of individual non-native Monterey pine trees in Estero and Limantour Road would have a localized minor to moderate long-term beneficial impact to native vegetation. For these beneficial impacts to persist, however, follow-up activities must be conducted to remove new recruits that come into the site in years following prescribed burning or mechanical treatments. Adverse, minor, short- to long-term impacts also could occur as a result of application of fire management activities if other non-native invasive plant species invade or spread on treated sites. Treatment of non-native Scotch broom has been successful, and may provide minor to moderate benefits to coastal scrub and grassland habitat in Highway One and Estero FMUs if applied throughout the area where it occurs. Prescribed burns and mechanical treatments in grasslands could have beneficial or adverse impacts, as results are highly variable. Monitoring and adaptive management would keep these impacts from becoming more than minor if they are adverse. Treatment of small patches broom and Monterey pine in pastures with mowing and prescribed fire could have moderate benefits if follow up activities are conducted.

Average unplanned wildfires and their suppression could have minor, short-term adverse or beneficial impacts on vegetation. Benefits may result from stimulation of fire dependent native species, or from the destruction of non-natives. Adverse impacts come from the loss of native species, as well as from crushing, removal or other physical impacts of suppression.

Mechanical fuel reduction in Bishop pine, Douglas-fir, and hardwood forests would result in negligible to minor short-term adverse impacts. Localized minor to moderate long-term benefits

to native vegetation would result from the mechanical removal of Monterey pine in Estero and Limantour Road FMUs. Moderate to major benefits to coastal scrub, grasslands and pasture from the continued removal of Scotch broom and French broom would result from the combination of mechanical mowing and prescribed burning techniques. The continuation of research and wide application of its results would increase these benefits over a wider geographic area.

Fuel build up and fire suppression continue to increase the chances and likely extent and intensity of a large wildfire under this alternative. In some native vegetation communities, such as Bishop pine or hardwood forest, large-scale fire could be beneficial by eliminating non-native species or otherwise creating conditions favoring the spread of native plants. In others, such as Douglas-fir/coast redwood forests, hot crown fires can destroy the seed source for a large area, making re-establishment difficult. Riparian areas may also experience major adverse impacts from hot fires from the destruction of seed source or root crown. The effect of a wildland fire in coastal scrub or grassland is more complex and less well understood, as some native and non-native species are benefited and some are adversely affected. Overall, the cumulative effects of a large-scale fire and all other activities such as development, historic logging, disease, and the introduction of exotics have and would continue to have major, long-term adverse impacts on native vegetation communities in the park.

No impairment to vegetation would result from this alternative.

Alternative B

Analysis

Prescribed Fire

Alternative B would treat vegetation in eight FMUs with prescribed fire, and would burn twice as many acres as Alternative A. Fire would be used in Inverness Ridge, Wilderness North and South, Bolinas Ridge, and Palomarin FMUs in addition to those identified in Alternative A.

In addition to continuing to use prescribed fire to reduce hazardous fuels along primary roads and to reduce the extent of broom and Monterey pine, Alternative B also would treat sites where fuel accumulations have created unsafe situations, and where reduction of fuel could help firefighters slow or stop the spread of fires in the event of an unplanned ignition, such as along Highway One. Burning would be conducted in the same FMUs for the same reasons as in Alternative A, although significantly more burning in shrublands and grasslands in Limantour Road and Bolinas Ridge FMUs would occur, primarily to reduce fuels.

Bishop Pine Forest
Alternative B includes the use of prescribed burns of less than 30 acres in Bishop pine forest in the Inverness Ridge FMU to determine if such burns effectively reduce understory biomass and dead and downed fuels, and if burning results in invasion by non-native species.

Bishop pine is relatively rare inside the park and in the region. The species occurs as relict stands in California along much of the coastline, on Santa Cruz and Santa Rosa islands, and in isolated

populations south to central Baja. As noted above, fire plays an important ecological role in maintaining Bishop pine forests. Stands of Bishop pine are characteristically even-aged, originating after fires, and their cones persist for many years, usually opening as a result of fire. Bishop pine stands are often dense, and stand-replacing crown fire typically occurs in such stands. It is hypothesized that a fire-free period of 80+ years would allow trees to succumb to diseases and die without reproducing.

Of the approximately 3,570 acres of Bishop pine forest in the park, 35% (1,250 acres) burned in the Vision wildfire. Following the fire, most of the pines in the area were dead and the formerly deep litter layer had been burned away. The bare, charred soil was covered with extremely large numbers of Bishop pine seeds. Regeneration in the burned area has been prolific, with dense stands of young Bishop pine growing up to replace the burned forests. One year following the fire, large dense patches of Bishop pine had recolonized the burned area.

Bishop pine burned in the Vision Fire were 26-45 years old. If additional testing finds stands nearing or exceeding 80 years, these sites would be ideal candidates for the pilot prescribed burns described above, as disease would likely otherwise take the adults. Prescribed fire would stimulate reproduction in these areas that would otherwise not take place.

Mitigation Measures

Prescribed burning in Bishop pine stands would occur only if the burns can be conducted under conditions that would result in germination and recruitment of new stands of Bishop pine. Relatively cool fires under moist conditions may not meet this objective.

Initially, prescribed burns in Bishop pine forest habitat would be small and would be carefully monitored to ensure burn objectives (= recruitment and long-term maintenance of Bishop pine and associated native species without introduction of invasive non-native plant species) are being met.

If pilot burns are successful in stimulating reproduction and keeping non-natives from invading, prescribed burning would have a minor long-term benefit to Bishop pine stands in Inverness Ridge FMU under this alternative.

Douglas-fir/Coast Redwood Forest

In this alternative, pilot burns to help managers determine how best to burn Douglas-fir and coast redwood would be conducted in at least three FMUs - Wilderness North, Wilderness South and Palomarin. To date, prescribed burns have not been conducted in any of these three FMUs.

Douglas-fir forests and coast redwood forests are the most common forest type in the project area, with Douglas-fir forest occupying approximately 90% of the forested area. Coast Douglas-fir can stand 250 feet or more and span 5-6 feet in diameter. They can live hundreds of years and are common in old-growth stands. The species is intolerant of shade, and requires fire or other disturbance to initiate a new cohort of seedlings. Mature Douglas-fir can be killed by ground fires, but thick bark offers enough protection of the majority of adult trees. Young Douglas-fir are susceptible to fire, and can also act as ladder fuels to carry fire to crowns of trees. When stem density is high, an intense crown fire can develop. Crown fires, or slow spreading ground fires

will commonly kill Douglas-fir trees over extensive areas. A prescribed burn of light to moderate intensity would remove ladder fuels, build-up of debris and could stimulate reproduction, as fir seeds ripen in burned cones and require relatively open conditions to sprout (Franklin and Dyrness, 1973), with resulting minor benefits to Douglas-fir forests.

Coast redwood (*Sequoia sempervirens*) is well adapted to fire. In other forests in Northern California (Annadel and Humboldt Redwood state parks), the fire regime prior to fire exclusion varied from every 2 to 6 years at one site to every 5 to 25 years at another. Recent prescribed burns resulted in stump sprouting where adults had been top killed. As redwoods achieved greater dbh, the probability of top-kill decreased. Flame length and fuel consumption were found to be the most important parameters in determining top-kill and basal sprouting. These parameters can easily be controlled by use of different firing patterns and fuel moisture to achieve the desired effects from a prescribed fire.

Seashore resource and fire managers are still working to determine the most effective methods for conducting prescribed burns in Douglas-fir and coast redwood forests in the project area. It would be beneficial, from both ecological and fire prevention perspectives, to reduce the density of some Douglas-fir stands, and to reduce the accumulations of ladder fuels. To do so safely, however, presents challenges. The NPS is considering the option of thinning smaller trees in selected stands of Douglas-fir prior to conducting prescribed burns. These trees would be no larger than 10 inches in diameter, and the thinning would be pre-approved by the Seashore's vegetation management staff prior to cutting. Removal of small-diameter trees removes the ladder fuels that carry fire into the crowns of larger trees, making prescribed burns safer to carry out.

Mitigation Measures

If pre-burn thinning of trees were required in forested stands, the trees to be thinned would be no larger than 10" in diameter.

Prior to conducting prescribed burning in Douglas-fir or coast redwood forests, Seashore fire and vegetation managers, and wildlife and plant ecologists would collaborate to fully develop rationale, objectives, prescriptions, and plans for conducting burns in the redwood forests within the project area.

Hardwood Forest

The responses of hardwood forests and their associated species to fire and fire suppression are variable, depending largely on characteristics of the dominant species. As most of the hardwood stands in the project area are strongly dominated by California bay and coast live oak, the effects of fire management activities on these species were primary considerations in this analysis.

California bay increases fuel loading by the continual shedding of its bark. Prescribed fire in hardwood forests has the potential to reduce this fuel load, and to stimulate reproduction, as studies indicate that germination of buried seed may slightly increase following light to moderate fire due to the cracking of the thin seed coat. Based on its prolific seedling ability and its ability

to stump sprout, it is unlikely that California bay in the project area would suffer any long-term adverse effects associated with prescribed fire, and may experience negligible or minor benefits.

As noted above in cumulative impacts (for Alternative A), coast live oak displays several characteristics that make it highly resistant to damage from fires. These features ensure that few large trees are killed by low to moderate-severity prescribed fire. Use of fire is recommended for managing coast live oak woodlands, and to maintain natural borders between Douglas-fir forests and coastal sage scrub or mesic chaparral communities. For example, Douglas-fir encroaches into hardwood forest in the park where fire has been suppressed. In scrub communities, the exclusion of fire has allowed coast live oak to increase in density, with resulting reductions in the diversity and abundance of understory species. Prescribed fire can be useful in both eliminating Douglas-fir in hardwood habitat and eliminating coast live oak in scrub habitat.

Alternative B does not include any prescribed burning in hardwood forests for the purposes of re-establishing more natural boundaries of this vegetation type, but instead would be used to treat fuel build-up as it is in other vegetation communities. Hardwood forest occurs in all FMUs slated for treatment with prescribed burning. The focus of prescribed burning would be to reduce fuels in all vegetation types, but primarily in scrub and grassland. Therefore, prescribed burning deliberately targeting fuel build-up in hardwood forests is unlikely. Instead, this vegetation type would experience negligible to minor benefits from incidental reductions in fuels and possibly from the stimulation of dormant seeds.

Overall, treatments are expected to result in beneficial, minor to moderate (depending on the number of acres treated) long-term impacts as a result of improved forest health.

Mitigation Measures

Site-specific objectives would be developed for prescribed burns in hardwood forest habitat. The intent of such burns may be to reduce density or abundance of this vegetation type to encourage coastal scrub development, or may be to enhance the ecological health of the hardwood plant communities. Unique, site-specific burn prescriptions and timing would be required to meet these differing objectives.

Monterey Pine/Monterey Cypress
Monterey pine would be treated by prescribed burning in Estero and Limantour Road FMUs as it is in Alternative A.

Riparian Woodland
No prescribed burning would take place in riparian woodland in any alternative.

Coastal Scrub
In addition to continuing and expanding the use of fire to control non-native broom and other species in coastal scrub, prescribed burns would take place in several FMUs to either reduce fuels or achieve resource objectives. There also may be incidental benefits to coastal scrub and to grasslands where scrub is encroaching through prescribed fires primarily intended to reduce fuels.

Coastal scrub is largely fire-dependent, with prominent shrubs establishing by seed and by sprouting. It is a flammable vegetation type that may burn again 1 to 2 years after fire if dry conditions exist. With fire in less than 5-year intervals, or with overgrazing, coastal scrub generally reverts to annual non-native grassland. Fire exclusion in coastal sage scrub and mesic chaparral communities allows coast live oak, California bay, and other shade tolerant species to increase in density and reduce understory diversity and abundance.

Fire exclusion in coastal prairie allows coyote brush establishment, with best establishment in wet years. Complete conversion of purple needlegrass tussock grassland to coyote brush/ripgut brome stands has been observed with 24 years of fire exclusion. Coyote brush forms a closed canopy in about 2 to 3 years after invasion.

As noted in cumulative impacts, the dominant species in coastal scrub in the project area is coyote brush. This species sprouts from its root crown and roots after above ground vegetation is killed by fire. Sprouting ability lessens when it is reburned.

In this alternative, coastal scrub in the Palomarin FMU would be burned to remove encroaching Douglas-fir and to maintain habitat for birds around the Point Reyes Bird Observatory. Burns would be less than 50 acres and effects would be monitored to determine if benefits of prescribed burning warrant a wider scale application. Douglas-fir trees less than 10" dbh would be cut before the area is burned to reduce risk of fire spread and to increase Douglas-fir mortality. Small prescribed burns in the Limantour Road corridor to reduce fuel accumulations in coastal scrub could have secondary resource benefits. Prescribed burns in the southernmost portion of Bolinas Ridge FMU in coastal chaparral and mixed scrub habitat to reduce fuels also would help stimulate reproduction in the rare, fire adapted species Marin manzanita and Mason's ceanothus.

In addition to minor to moderate benefits to this community from removing Scotch and French broom, additional minor benefits to coastal scrub health and reproductive rates are likely due to pilot burns at Palomarin and the use of prescribed fire to reduce fuels.

Mitigation Measures

Small pilot burns (> 50 acres) would be conducted in coastal scrub. These burns would be carefully monitored to ensure burn objectives (= recruitment and long-term maintenance of native species without introduction of invasive non-native plant species) are being met. If pilot projects determine objectives can be met using prescribed fire, individual burn size would increase to a maximum of 200 acres.

Grassland

Prescribed burns and mechanical treatments would occur in grasslands in numerous FMUs under Alternative B. In Limantour Road FMU, additional burning specifically to reduce fuels in grasslands would take place along the road corridor and around developed areas in the park. The same is true of Highway One FMU. Grasslands and shrublands along Bolinas Ridge and in grasslands along the Bolinas Ridge Fire Road would be burned to reduce fuels. Treatments would occur primarily along road edges, and around structures to reduce fire hazard.

As noted in Alternative A, prescribed burning in grasslands must be precise and monitored carefully to achieve desired results as non-native grasses are sometimes favored by fire. For example, while a combination of prescribed fire and mowing has been successful in removing Scotch broom from some grassland communities, prescribed burning of the highly invasive purple velvet grass may be increasing its abundance. Monitoring and adaptive management (e.g., changing the prescription if non-natives are not destroyed) are mitigation measures that would be used to minimize potential adverse effects of prescribed burning in grasslands.

Mitigation Measures

All grassland burns would be carefully monitored to ensure burn objectives (= recruitment and long-term maintenance of native species without introduction of invasive non-native plant species) are being met.

To enhance grassland plant species composition, and reduce the chance of invasion or spread of non-native species, native seeding trials would be conducted following fire management treatments in some areas.

Impacts of these activities on vegetation are expected to be adverse, negligible to minor, and short- to long-term if non-native species expand in density or aerial extent as a result of treatments. Beneficial, minor to moderate, long-term impacts to vegetation would occur in some areas of grassland habitat as stands of Scotch or French broom are reduced.

Pasture

Under this alternative, small areas supporting the non-native species Scotch broom, French broom, or Monterey pine within pasture may be burned or mowed to reduce the density and aerial extent of these invasive species. Impacts associated with these efforts would be beneficial, minor to moderate, and long-term as a result of removal of invasive non-native plants. For these beneficial impacts to persist, however, follow-up activities must be conducted to remove new recruits that come into the sites in years following prescribed burning or mechanical treatments. Adverse, minor, short- to long-term impacts also could occur as a result of application of fire management activities if other non-native invasive plant species invade or spread on treated sites.

Unplanned Ignitions, Wildland Fire, and Suppression

The impacts described above from average wildland fire and suppression for Alternative A would be true of this alternative as well.

Mechanical Treatment

Alternative B would treat twice as many acres as Alternative A with mechanical means, and would add mechanical treatment in the following FMUs: Tomales Point, Inverness Ridge, Wilderness North and South and Palomarin. As in Alternative A, the focus of mechanical treatment would be to control non-native species and reduce fuels. In addition, mechanical treatment would be used where reduction of fuel could help firefighters slow or stop the spread of fires in the event of an unplanned ignition, such as along Inverness Ridge.

Bishop pine
In addition to the mechanical treatment identified in Alternative A, concentrations of fuels would be reduced by limbing bishop pine along primary roads and along secondary fire roads. A 3 mile long fuel break in Inverness FMU also may result in some removal of Bishop pine. The fuel break would be 50-60 feet wide. Within it, dead and downed woody debris would be reduced by 60%, trees would be limbed up to 10 feet in height, trees up to 4 inches in diameter would be thinned and brush would be cut in a mosaic pattern to break up fuel continuity. The creation of the fuel break could mean a reduction in the risk of a catastrophic fire spreading. It also may provide minor benefits to Bishop pine by opening the canopy to sunlight and promoting the opening of this species' cones

Douglas-fir/Coast redwood
Under this alternative, thinning of Douglas-fir/coast redwood would take place along the sides of roads, including Limantour Road and Highway One. Trees less than four inches in diameter would be removed from a corridor 10-15 feet wide on each side of the road, and larger trees would be limbed up to a height of 10 feet. This would help to create a corridor of defensible space along these roads. Douglas-fir/redwood forests also would be subject to mechanical thinning prior to prescribed burning in Wilderness North and Wilderness South FMUs to increase the ability to control prescribed and wildland fire. Mechanical treatments are expected to cause beneficial, minor to major (depending on the number of acres treated) long-term impacts as a result of improved forest health and reduced risk of large-scale unplanned catastrophic wildland fire.

Monterey pine/Monterey cypress
Both Monterey pine and Monterey cypress would be treated by mechanical means in Alternative B. Monterey pine would be cut and the stumps treated with herbicide in both Estero and Limantour FMUs. Monterey cypress would be cut and stump treated in Tomales Point and Estero FMUs. Because the distribution of both species is limited, this approach of treating individual trees could substantially reduce their extent, and impacts to native vegetation could be minor to moderate, long-term and beneficial. For these beneficial impacts to persist, however, follow-up activities must be conducted to remove new recruits that come into the site in years following mechanical treatments.

Hardwood Forest
Thinning along roadsides would continue in Alternative B as it does in Alternative A, and some hardwood species would be removed or limbed. Alternative B would also target non-native eucalyptus for mechanical removal in several FMUs.

Eucalyptus forests in the park are dominated by the non-native blue gum eucalyptus, which has been planted and has encroached on native plant communities. Eucalyptus is usually highly dominant in the canopy. Monterey pine, Monterey cypress, or individual Douglas-fir, California bay, or coast live oak also may be present. Understory vegetation usually is sparse, often including remnants of the native community, because eucalyptus creates a deep litter containing chemicals that discourage growth of other species. Poison oak and non-native or native berries (e.g., *Rubus* spp.) are common shrubs. Other non-native shrubs and herbs often are present with

low cover. The floor of eucalyptus forests is characterized by a thick layer of eucalyptus litter comprised of bark, seedpods, leaves, and branches.

The combination of thick litter, hanging strips of bark, and volatile chemicals in the wood and litter of eucalyptus mean a fire in these forests is highly likely to burn hot and reach the crown. Fire does not kill adult trees, but does open seedpods and prepare the seedbed, enhancing regeneration. As noted above, it is the policy of the NPS to promote native species and remove non-native plants and animals as parks are able to do so. In Alternative B, eucalyptus stands in Tomales Point, Estero, and Highway One would be targeted for thinning or removal, with larger trees stumps treated with herbicides to prevent resprouting. Mechanical removal of individual eucalyptus trees could have minor to moderate benefits for native vegetation.

Table 51. Eucalyptus Acreage occurring within Fire Management Units.

Fire Management Unit	Alternative A	Alternative B	Alternative C
Tomales Point		17	17
Headlands			
Estero	11	11	11
Inverness Ridge			
Limantour Road	14	14	14
Wilderness North		3	3
Wilderness South			
Highway One	94	94	94
Bolinas Ridge			
Palomarin		26	26
Totals	119	165	165

Riparian Woodland
No mechanical treatment would occur in riparian woodland in any alternative.

Coastal Scrub
Impacts from mechanical treatment of coastal scrub would be the same as described for Alternative A. Mowing to target Scotch and French broom would continue and expand, with possible moderate or even major beneficial impacts to native coastal scrub species.

Grassland
Scotch and French broom also occur in grasslands, where mechanical treatment by mowing would be used to help control the spread of these species. Possible moderate benefits to grasslands would occur from their removal.

Pasture
As noted above, treatment would generally not occur in pasture, although some mowing of Scotch and French broom is possible with minor or moderate benefits.

Coastal Dune
Coastal dunes occur in the Tomales Point FMU. These dunes are largely dominated by the non-natives plants European beachgrass and iceplant. The Seashore is undergoing a large-scale dune restoration program that involves manual and mechanical removal of European beachgrass. Mechanical removal of this non-native would have minor beneficial effects on native dune species.

Fire Information/Education

Same as Alternative A.

Fire Cache/Park Headquarters Relocation and Construction

Same as Alternative A.

Fire Effects and Fuel Management Research

Alternative B includes the use of pilot burns in Douglas-fir and coastal scrub communities to determine effects in promoting native species and reducing or removing fuels and non-native species. In Bolinas Ridge FMU, the effects of prescribed burning on native plant species richness would be explored, and in Palomarin FMU, the effects on birds would be assessed. If effects are beneficial, and such treatments are later applied to large areas of the park, widespread minor to major benefits to vegetation could result.

Cumulative Impacts

The risk of unplanned wildland fire would be slightly less under Alternative B (as compared to Alternative A) as mechanical treatments and prescribed burning would be designed and implemented to reduce such risk. However, the impacts described above for Alternative A would be the same for this alternative, with short- to long-term, major adverse impacts to vegetation possible.

Conclusion

Similar impacts to those for Alternative A from prescribed burning would occur in Monterey pine forests and pasture. Minor to moderate benefits from prescribed burning in hardwood forests are possible. Pilot burns in Douglas-fir forests could provide minor benefits by removing ladder fuels and debris and stimulating reproduction. Removal of non-native Monterey pine trees in Estero and Limantour Road FMU would have a localized minor to moderate long-term beneficial impact to native vegetation, but minor adverse impacts could also occur from burning if non-native species increase their aerial extent. Continued treatment of non-native Scotch broom may provide minor to moderate benefits to coastal scrub and grassland habitat if applied throughout the area where it occurs. Additional minor benefits to coastal scrub from prescribed burning to increase native species richness would occur in Palomarin and Bolinas Ridge FMUs. Prescribed burns and mechanical treatments in grasslands could have beneficial or adverse

impacts, as results are highly variable. Monitoring and adaptive management would keep these impacts from becoming more than minor if they are adverse.

Average unplanned wildfires and their suppression could have minor, short-term adverse or beneficial impacts on vegetation. Benefits may result from stimulation of fire dependent native species, or from the destruction of non-natives. Adverse impacts come from the loss of native species, as well as from crushing, removal or other physical impacts of suppression.

Mechanical fuel reduction in Bishop pine, Douglas-fir and hardwood forests would result in negligible to minor, short-term adverse impacts. Addition minor long-term beneficial or adverse impacts from the removal of several acres of bishop pine to create a fuel break in Inverness FMU would occur. Localized minor to moderate long-term benefits to native vegetation would result from the mechanical removal of Monterey pine in Estero and Limantour Road FMUs, of Monterey Cypress from Tomales Point and Estero FMUs, and of eucalyptus from Tomales Point, Estero, and Highway One FMUs. Moderate to major benefits to coastal scrub, grasslands, and pasture from the continued removal of Scotch broom and French broom would result from the combination of mechanical mowing and prescribed burning techniques. The continuation of research and wide application of its results would increase these benefits over a wider geographic area.

The risk of a large wildfire, and its likely extent should it occur, would be less under Alternative B, as compared to Alternative A, especially after several years of treatment have taken place. In some native vegetation communities, such as Bishop pine or hardwood forest, large-scale fire could be beneficial by eliminating non-native species or otherwise creating conditions favoring the spread of native plants. In others, such as Douglas-fir/coast redwood forests, hot crown fires can destroy the native seed source over a large area, making re-establishment difficult. Riparian areas also may experience major adverse impacts from very intense fires due to destruction of seed source or root crown. The effect of a wildland fire in coastal scrub or grassland is more complex and less well understood, as some native and non-native species are benefited and some are adversely affected. Overall, the cumulative effects of a large-scale fire and all other activities such as development, historic logging, disease and the introduction of non-native plant species have and would continue to have major, long-term adverse impacts on native vegetation communities in the park.

No impairment to vegetation would result from this alternative.

Alternative C

Alternative C would include all activities as described above for Alternative B, and would include prescribed burning on an additional 1000 acres per year (to total 2000 acres of prescribed burning) and would include mechanical treatment on up to 1500 acres per year. In addition to more treatment to reduce fuels and increase the ability to fight wildfires, under Alternative C, the Seashore would use fire and mechanical means to enhance the condition of natural and cultural resources. Some treatment of natural resources would involve the widespread attempt to eliminate non-native species, but treatment to improve species richness and wildlife habitat also

would occur. Alternative C is the only alternative to use prescribed fire in Tomales Point and Headlands FMUs.

Analysis

Prescribed Fire

Bishop Pine Forest
The same treatment and resulting impacts of incidental use of prescribed fire in Bishop Pine as described in Alternative B are expected. However, additional research would be conducted to determine the effects of burning on Bishop pine populations and associated plant species, as well as on dusky-footed woodrats (Northern Spotted Owl prey species) and on Point Reyes mountain beavers.

Douglas-fir/Coast Redwood Forest
Additional pilot burns in Douglas-fir/coast redwood forests may be conducted in this alternative, with resulting benefits from reductions in ladder fuels and increased reproductive response. Eventually, fire would be reintroduced to Douglas-fir forests in some FMUs (Wilderness North and Wilderness South), returning a natural environmental process that has been lost or altered for at least a century. The benefits to these stands of Douglas-fir/coast redwood could be major and long-term, depending on the aerial extent of treatment.

Hardwood Forest
Prescribed burning could occur in hardwood forests in nine of the ten FMUs subject to treatments under Alternative C (the remaining FMU - Headlands - does not support these forest types). Because eucalyptus is a non-native hardwood species highly adapted to fire, treatments would include consideration of eucalyptus ecology and whether or not treatment would cause it to spread. In both this alternative and in Alternative B, eucalyptus would be mechanically thinned or removed for this reason. Because other California hardwood species are also fire-adapted, removing exotics mechanically and then burning would result in beneficial, moderate to major (depending on the number of acres treated) effects. Beneficial impacts under Alternative C would be greater than under Alternative B because twice the acreage could be treated.

Monterey Pine/Monterey Cypress
Both Monterey pine and Monterey cypress would be subject to prescribed burning in Alternative C. Monterey cypress (see Alternative A for information on Monterey pine) is fire-adapted in that its cones require heat to open, but it is capable of establishing seedlings with or without crown fire. In California, late summer or early fall fires are followed by winter rains. These provide exposed mineral soil for seeds and moist conditions ideal for germination. Although some larger Monterey cypress adults may survive fire, the majority of wildfires would kill most individuals. The frequency of fire is important in managing non-native Monterey cypress. If groves are burned with prescribed fire often, reproduction could be eliminated, as remaining trees would be unable to mature and produce cones. Fire followed by intensive grazing also could eliminate a cypress grove. Prescribed burning of Monterey cypress would occur in Estero FMU, and could have a minor to moderate benefit on native vegetation in areas where this species now dominates.

Coastal Scrub
In addition to the impacts described above for Alternative B, this alternative includes small prescribed burns in the Tomales Point FMU to determine the response of plant communities, including plant species of special concern.

Grassland
In addition to the use of fire as described in Alternatives A and B, small prescribed burns in grasslands in Tomales Point and Headlands FMUs would occur in Alternative C. In Tomales Point, fire would be applied based on previous research results in other California grasslands to encourage a larger proportion of native species to become established. In Headlands FMU, pilot burns on velvet grass would be conducted to determine if burning will reduce the aerial extent and density of this species. As in other alternatives, the prescriptions would be fine-tuned in grasslands to ensure native species are favored. Minor to moderate benefits from these pilot burns are possible if they are successful and applied widely.

Mitigation Measures
In the Tomales Point FMU, small pilot burns (less than 100 acres) would be conducted in grassland to determine plant community response. These burns would be carefully monitored to ensure burn objectives (= recruitment and long-term maintenance of native species without introduction of invasive non-native plant species) are being met. If pilot projects determine objectives can be met using prescribed fire, individual burn size would increase to a maximum of 150 acres.

Pasture
Impacts would be similar to those described above for Alternative B.

Coastal Dune
Coastal dunes cover a small number of acres in the FMUs slated for treatment, primarily in the Headlands FMU, and to a lesser degree in the Tomales Point FMU. These dunes are largely dominated by the non-native plants European beachgrass and iceplant. The Seashore is undergoing a large-scale dune restoration program that involves manual and mechanical removal of European beachgrass, and piles of beachgrass that have been pulled may be burned. Because they are non-native, removing these species through burning would be beneficial, minor, and long-term.

Unplanned Ignitions, Wildfire, and Suppression

The impacts described above from average wildland fire and suppression for Alternative A would be true of this alternative as well.

Mechanical Treatment

Alternative C would treat three times as many acres as Alternative A with mechanical means, and would treat more acres within the same FMUs as Alternative B. The focus of mechanical treatment would be the same as in Alternative B, and the reasons for mechanical treatment would

remain virtually the same as in Alternative B. Only the extent of treatment would change. Because of this, vegetation types are not analyzed individually in Alternative C.

Fire Information/Education

Same as Alternative A.

Fire Cache/Park Headquarters Relocation, and Construction

Same as Alternative A.

Fire Effects and Fuel Management Research

Under Alternative C, the fire management program would be guided to a greater degree than in other alternatives by the results of research on the ecological effects of fire and mechanical treatments. Ongoing research on Scotch broom, velvet grass, and rare chaparral plants would continue, and research on the effects of prescribed burning would expand into additional habitat types, including coastal grassland, Douglas-fir forest, riparian woodland, and Bishop pine forest. If the results of these studies are ecologically favorable (e.g., lead to increased native species richness, create areas supporting a variety of age classes within habitat types, and/or result in increases in rare species abundance or distribution) additional prescribed burning would occur in subsequent years in those habitat types.

Under this alternative, the research program also would be expanded to include studies on the effects of mechanical fuels treatments on ecological parameters. Vegetation would be selectively removed from within Douglas-fir forests and in shrub-dominated habitats such as coastal scrub and chaparral to determine the effects of such removal on physical and biological elements (e.g., soils, selected plant species).

Cumulative Impacts

The risk of unplanned wildland fire would be moderately reduced under Alternative C (as compared to Alternative A) as mechanical treatments and prescribed burning would be designed and implemented to reduce such risk. However, the types of impacts described for Alternative A would be the same for this alternative should a wildfire occur, with short- to long-term, major adverse impacts to vegetation possible.

Conclusion

In the FMUs treated with prescribed fire, minor, short-term adverse impacts associated with loss of vegetation, and the possibility of introduction or spread of non-native plants could be greater than under other alternatives. However, the burns also would result in minor to moderate beneficial impacts as burns would stimulate growth of many native plant species, and would kill non-native vegetation. Although they would remain moderate, the potential for beneficial effects from Alternative C are greater than Alternative A or Alternative B because 2000 acres would be treated.

Mechanical fuel reduction would have minor short-term adverse impacts on native vegetation through crushing or other physical impacts, but clearing of dense vegetation also would have possibly long-term, minor to moderate benefits on most plant communities as well. The effects would be greater under this alternative than under Alternative A or Alternative B because more acres would be treated.

All of the beneficial impacts for prescribed burning and mechanical treatment described for specific vegetation types in Alternative B also would occur in this alternative. These include minor benefits to Douglas-fir forests by removing ladder fuels and debris and stimulating reproduction, minor to moderate benefits from removal of Monterey pine and Monterey cypress through prescribed burning and mechanical means, minor to major benefits to coastal scrub and grassland habitat from the removal of Scotch and French broom, and minor benefits to coastal scrub from prescribed burning to increase native species richness. Additional possibly major benefits to Douglas-fir forests from the return of natural fire intervals following treatment with prescribed burning are likely, and minor benefits to coastal dune vegetation from the burning of non-native beachgrass is possible.

Average unplanned wildfires and their suppression could have minor, short-term adverse or beneficial impacts on vegetation. Benefits may result from stimulation of fire dependent native species, or from the destruction of non-natives. Adverse impacts come from the loss of native species, as well as from crushing, removal or other physical impacts of suppression.

Adverse and beneficial impacts from mechanical treatment would be very similar to those in Alternative B. These include negligible to minor short-term impacts to forest vegetation from killing individuals, balanced with minor to moderate beneficial impacts associated with fuel reduction and thinning; localized minor to moderate long-term benefits to native vegetation from the mechanical removal of Monterey pine, Monterey cypress and eucalyptus; and moderate to major benefits to coastal scrub, grasslands, and pasture from the continued removal of Scotch broom and French broom. The continuation of research and wide application of its results would increase these benefits over a wider geographic area.

The risk of a large wildfire, and its likely extent should it occur, would be reduced under Alternative C (compared to Alternative A), especially after several years of treatment have taken place. In some native vegetation communities, such as Bishop pine or hardwood forest, large-scale fire could be beneficial by eliminating non-native species or otherwise creating conditions favoring the spread of native plants. In others, such as Douglas-fir/coast redwood forests, fires could either have substantial beneficial effects or hot crown fires could destroy the seed source over a large area, making re-establishment difficult. Riparian areas may also experience major adverse impacts from hot fires from the destruction of seed source or root crown. The effect of a wildland fire in coastal scrub or grassland is more complex and less well understood, as some native and non-native species are benefited and some are adversely affected. Overall, the cumulative effects of a large-scale fire and all other activities such as development, historic logging, disease, and the introduction of exotics have and would continue to have major, long-term adverse impacts on native vegetation communities in the park.

No long-term impairment to vegetation would result from this alternative.

IMPACTS TO WETLANDS

Alternative A

Analysis

Impacts to wetlands associated with fire management activities are similar in many respects to impacts described in the preceding sections on soils and vegetation. Impacts on wetland sites, however, can differ from impacts on upland sites because wetlands usually have a higher level of soil moisture and denser vegetation cover than non-wetlands, which can result in variable impacts. These conditions can result in wetlands being more vulnerable to impact from certain activities. For example, fire suppression activities such as cutting handline or dozerline in wetlands can be very destructive if conducted when soils are wet. Although any site, either upland or wetland, can have high soil moisture at certain times of the year, it is more likely that wetland sites will be wetter year round, and therefore these sites require additional consideration, and different mitigation measures, to ensure their protection. Additionally, the higher level of legal protection that is afforded wetlands requires that additional care be taken to protect these sites.

There is little literature available that describes the specific effects of fire on wetland ecosystems, particularly for wetlands in the western United States. This lack of information is discussed by researchers with the United States Geological Survey Northern Prairie Wildlife Research Center, who compiled the web-based "Fire in North American Wetland Ecosystems and Fire-Wildlife Relations: An Annotated Bibliography." In the Introduction to the bibliography, they state:

"Surprisingly few papers have addressed aspects of fire-wetlands relations; fewer yet have had this subject as a major focus of investigation. In general, fire has been treated as one of a number of management tools appropriate for wetlands, with its major use that of eradication of undesirable vegetation. Unlike the literature on fire in terrestrial upland communities, however, specific fire prescriptions, knowledge of fire behavior under different fuel loadings and environmental conditions, and the detailed consequences of differing fire frequencies, fire intensities, and fire severities in wetlands are largely unknown."

Despite this lack of specific information, as with all vegetation types, impacts of fire on wetlands are a function of 1) the severity of the fire itself, and 2) characteristics of the particular plants on the site.

Two pieces of evidence suggest burning in wetlands has some benefits. First, the landscape of Point Reyes is one that has periodically burned over time (see Fire History in Affected Environment), and fires have included wetlands. Second, research of effects in wetlands shows that, if burned areas retain seed of native species in the soil, or if burns create a mosaic pattern with some surviving native vegetation or resprouting native vegetation, within a few years it can be difficult to determine that a fire recently occurred (Miller, 2000). It is also known that some

species of wetland plants are stimulated to reproduce through seed germination, and by sprouting from stems, roots or rhizomes following fires.

Prescribed Fire

Burn plans that include prescribed burning in wetland areas are subject to the conformance with additional regulations when applying to BAAQMD. In addition to the SMP and other submittals, Regulation 5, Section 410, Marsh Management Burn Requirements, asks for an evaluation of non-burning alternatives that could achieve land management objectives in keeping with resource management plans that apply to the project area. Regulation 5, Section 401.13 includes more detailed guidance for planning prescribed burns that involve wetland acreage.

This alternative would not specifically burn wetland areas with prescribed fire, although it would not include any measures specific to keep nearby burns from entering wetlands. Marsh and other wetlands occur in three of the four FMUs that could be receive prescribed burning (Estero, Limantour Road and Highway One). Prescribed fire would be used in these three FMUs to treat Scotch broom, French broom, and Monterey pine. These would be low to moderate intensity burns, which generally burn near or around moist wetland soils, rather than in the wetlands themselves. However, burning in grasslands to eradicate broom for example could result in some encroachment of non-native grasses or other plant species, which may also invade the adjacent wetland. If burns are prescribed in the summer or fall, when seasonal wetlands are dry, some impact from the loss of vegetation is possible. In dry years, prescribed fire may burn into perennial wetlands as well. These are possible minor adverse impacts, but the burns could also have minor to moderate beneficial impacts on wetland vegetation by stimulating growth and reproduction in native wetland species, and possibly by killing non-native species.

Unplanned Ignition, Wildfire, and Suppression

The potential impacts of wildland fire suppression on wetlands are similar to potential impacts of wildland fire suppression on other vegetation classes as described in the previous section (Impacts on Vegetation). Due to increased moisture levels often present in wetlands, however, such impacts can be more severe.

Point Reyes has had an average of three unplanned fires annually, with each fire burning less than ten acres. As these are unplanned events, information on direct effects can only be obtained after the fire, and would involve documenting effects on resources for which little pre-burn data may exist. The impacts on wetlands associated with these small unplanned wildfires and their suppression are expected to be both adverse and beneficial. Adverse impacts are expected to be minor and short-term. It is possible that small invasions of non-native plants would result from these fires, which could result in a longer-term impact, but the impact would be localized. Small unplanned wildland fires in the project area may have some beneficial impact on wetlands in localized areas if non-native plants are killed, and native plants establish on the site following the fire.

Mechanical Treatment

Up to 500 acres of mechanical treatment in Estero, Limantour Road, and Highway One FMUs would be conducted under this alternative. All of these FMUs have wetland acreage, although no treatment of wetlands specifically would take place.

Mechanical treatments would avoid wetland areas to the greatest extent possible. If such treatments in wetlands were deemed necessary to ensure fire safety around structures or along roads, these treatments would have adverse impacts on vegetation. Some native vegetation would be killed or damaged, and treatments could result in localized introduction or spread of non-native species. These impacts would be considered adverse, negligible to minor, and short-term. In some cases, clearing of dense vegetation could result in increased growth or establishment of native wetland species by creating gaps or openings in canopy cover, and could result in a decrease in non-native plants on treated sites. These impacts would be considered beneficial, minor, and short- to long-term.

Fire Information/Education

This would have no beneficial or adverse effects on wetlands.

Fire Cache/Park Headquarters Relocation, and Construction

The construction of a fire cache at Bear Valley would not have a beneficial or negative impact on wetlands. The building would be located at least 100 feet from the Bear Valley Creek riparian zone and temporary construction plastic fencing would be used to eliminate any impacts to resources in this zone. In addition, the site is a former trailer pad and nearly unvegetated and no wetlands are located on the construction site.

Fire Effects and Fuel Management Research

This would have no adverse effects on wetlands. Any post-treatment monitoring would have an indirect benefit by providing greater knowledge of the effects of prescribed fire and mechanical treatments on wetlands in the project area.

Mitigation Measures

Burns would be allowed to back into and burn around wetlands and meadows or through them if the vegetation is dry enough to carry fire. Wetlands would be avoided to the greatest extent possible during fire confinement and containment.

Fire suppression activities would not occur in wetlands unless there are no alternatives available to control the spread of a wildland fire.

Fires near wetlands would be ignited when wetlands are too moist to sustain fire spread, thereby minimizing impacts to wetlands.

To the greatest extent possible, mechanical treatments would not occur in wetlands.

Wetlands may be used as a natural boundary for prescribed fires. When a wetland area is being used as a boundary, line construction would occur in adjacent uplands, not in wetlands.

Prescribed fires would not occur more frequently than the time required for native plant species to set seed.

Foams or other fire retardants would not be used in or near wetlands.

Firebreaks or firelines would be constructed in previously disturbed areas whenever possible.

Chipped material would not be spread in wetlands.

Cumulative Impacts

Cumulative impacts to wetlands include pollution, runoff, encroachment of non-native species, and draining or deepening for development on land or of marinas. In the park, projects listed in Appendix C could have combined impacts on wetlands, but the chance of this is remote, since wetlands are protected by special legislation and NPS policies prohibit development within a wetland when other options are available. Therefore impacts to wetlands in the study area from all but a large wildfire, should it occur, are negligible or minor.

Treatment of 1000 acres per year by prescribed fire and mechanical means to reduce fuel loads would have little effect in reducing the risk of a large wildfire, even over several years. High-severity fires in Point Ryes such as the Vision Fire are characterized by extensive burned areas that may be continuous from ridgeline to slope bottom and include riparian areas and wetlands. The direct effects of high intensity wildland fires on wetlands can be substantial, including the destruction of both wetland vegetation and the seeds, roots, and rhizomes that would have allowed native species to repopulate. Over the long-term, permanent changes in plant species composition or percent cover, and the introduction or spread of non-native invasive plant species can result. Revegetation of wetlands could take many years. During extreme weather events, debris torrents would potentially scour streams, further delaying restoration of the riparian community and associated wetlands. Because non-native species also exist in the park, colonization of wetlands by these species or even habitat type conversions is possible with intense wildfires.

Large, high-intensity fires also can cause ecosystem fragmentation, which can create barriers to wildlife movements and affect seed sources, nutrients, and plant distribution patterns in wetland communities. Loss of vegetation in a wetland can reduce the ability of the wetland to filter incoming surface water flows, resulting in changes in water quality; can lead to increased soil erosion in or near the wetland; and can cause an increase in water temperatures if the wetland supports open water.

Activities to suppress large wildland fires could have substantial, although localized, impacts if wetlands are treated with retardant, or if a fireline is constructed. Such activities would not occur in wetlands to the greatest extent possible. The actual extent and magnitude of impacts are impossible to predict, however, as these fires are unplanned. All of these impacts would be mitigated following a fire with assistance from the NPS Burned Area Emergency Rehabilitation (BAER) program.

Overall, impacts to wetlands from a large wildfire could be major, long-term, and adverse.

Conclusion

Minor adverse impacts are possible from prescribed fires burning near and into wetlands in dry years. Minor to moderate benefits on wetland vegetation are possible if fire intensity is low to moderate due to reduction of non-native plant species or stimulation of germination and resprouting in native species.

Minor adverse impacts from unplanned wildfires and their suppression could occur. Minor beneficial effects also could occur due to reduction of non-native plant species or stimulation of germination and resprouting in native species.

Mechanical treatments would avoid wetland areas to the greatest extent possible. If such treatments in wetlands were deemed necessary to ensure fire safety around structures or along roads, these treatments would have negligible to minor adverse impacts on vegetation. Clearing vegetation also could have minor benefits to wetland species if native species establishment is enhanced.

Cumulative impacts from development in the park may have a minor adverse impact on wetlands. However, a large-scale wildfire could have major, long-term, adverse impacts on wetlands from destruction of vegetation and reproductive ability, and invasion by non-native species.

No long-term impairment to wetlands would result from this alternative.

Alternative B

Analysis

Prescribed Fire

Under Alternative B, up to 1000 acres per year would be treated using prescribed fire in the Estero, Inverness Ridge, Wilderness North, Wilderness South, Limantour Road, Highway One, Palomarin, and Bolinas Ridge FMUs. Wetlands are present in all of these FMUs except Bolinas Ridge, although no treatment directed at wetlands would occur.

Wetland areas would generally be avoided and buffered from burns. However, if prescribed burns are allowed to burn into adjacent wetlands, minor impacts from killing wetland vegetation

occur. These would be offset by minor to moderate benefits from killing non-native species and from stimulating reproduction of many native plant species. The effect of Alternative B would be greater than Alternative A because 1000 acres would be treated.

Unplanned Ignition, Wildfire, and Suppression

Same as Alternative A.

Mechanical Treatments

Mechanical fuel reduction techniques would have both adverse and beneficial impacts on wetland vegetation. Some native vegetation would be killed or damaged, and treatments could result in localized introduction or spread of non-native species. These impacts would be considered adverse, short-term, and minor. The impacts would be minor because wetland areas would be avoid and buffered from mechanical treatments. In some cases, however, clearing of dense vegetation could result in increased growth or establishment of native and rare species. These impacts would be considered beneficial, possibly long-term, and minor to moderate. The effects would be greater under this alternative than under Alternative A because twice as many acres would be treated.

Fire Information/Education

Same as Alternative A.

Fire Cache/Park Headquarters Relocation, and Construction

Same as Alternative A.

Fire Effects and Fuel Management Research

Same as Alternative A.

Cumulative Impacts

Same as Alternative A.

Conclusion

Although wetland vegetation would be avoided and buffered from nearby prescribed burning or mechanical treatment for the most part, some of each of these treatments may take place for resource management or safety reasons. If so, minor localized adverse impacts from either to vegetation could occur from crushing, removal, or burning. However, minor to moderate benefits from killing non-native vegetation or stimulating reproduction is also possible.

Minor adverse impacts from unplanned wildfires and their suppression could occur. Minor beneficial effects also could occur due to reduction of non-native plant species or stimulation of germination and resprouting in native species.

Cumulative impacts from development in the park may have a minor adverse impact on wetlands. However, a large-scale wildfire could have major, long-term adverse impacts to wetlands from destruction of vegetation and reproductive ability, and resulting invasion by non-native species. This is true despite the reduced risk of such a fire related to fuel reduction activities across the project area in this alternative.

No long-term impairment to wetlands would result from this alternative.

Alternative C

Analysis

Prescribed Fire

Under Alternative C, a total of 2000 acres per year would be treated using prescribed fire in all of the same FMUs as in Alternative B, and in Tomales Point and Headlands FMUs as well. Wetlands are present in all but the Bolinas Ridge FMU.

Impacts would be similar to those described above for Alternatives A and B. Although adverse impacts may be greater than other alternatives, they would remain short-term and minor because wetlands are largely kept unburned and are buffered from nearby prescribed burns. Benefits from killing non-native plants or stimulating regrowth of natives would be minor to moderate as they are in Alternative B.

Unplanned Ignition, Wildfire, and Suppression

Same as Alternative A.

Mechanical Treatments

Adverse and beneficial impacts from mechanical treatment in this alternative would be similar to those described above for other alternatives. Minor adverse effects from killing or damaging wetland vegetation are possible but unlikely, and minor to moderate benefits from clearing dense vegetation and encouraging establishment of wetland vegetation may occur. The effects would be greater under this alternative than under Alternatives A and B because more acres would be treated.

Fire Information/Education

Same as Alternative A.

Fire Cache/Park Headquarters Relocation, and Construction

Same as Alternative A.

Fire Effects and Fuel Management Research

Same as Alternative A.

Cumulative Impacts

Same as Alternative A.

Conclusion

Prescribed burns would have minor, short-term adverse impacts because fire would kill some wetland plant species, and could result in the introduction or spread of non-native vegetation. The effect of Alternative C would be greater than Alternatives A and B because 2000 acres would be treated.

Minor adverse impacts from unplanned wildfires and their suppression could occur. Minor beneficial effects also could occur due to reduction of non-native plant species or stimulation of germination and resprouting in native species.

Mechanical fuel reduction techniques would have both adverse and beneficial impacts on wetland vegetation. Some native vegetation would be killed or damaged, and treatments could result in localized introduction or spread of non-native species. These impacts would be considered adverse, short-term, and minor.

Cumulative impacts from development in the park may have had a minor impact on wetlands. However, a large-scale wildfire could contribute major, long-term adverse impacts to wetlands from the destruction of vegetation and reproductive ability, and resulting invasion by non-native species. This is true despite a moderate reduction in risk of such a fire related to fuel reduction activities across the study area in this alternative.

No long-term impairment to wetlands would result from this alternative.

IMPACTS TO WILDLIFE

Types of Impacts

The types of impacts on wildlife caused by prescribed fire and small-scale wildland fire are similar. Quantifying or accurately predicting such effects is difficult because fire is inherently unpredictable. For example, fire intensity (which strongly influences the degree of impacts) varies substantially in response to season, wind, air temperature, relative humidity, composition of fuels, topography, and other parameters. Because of the inability to predict the nature of

wildland fires, this analysis of the effects of wildfire on wildlife is qualitative. The effects of prescribed burning on wildlife are somewhat more predictable and easier to mitigate through careful planning and implementation; nonetheless credible scientific data on such effects in the project area are scant.

Generally, the effects of fire on wildlife depend on the characteristics of the fire itself (e.g., intensity, duration, frequency, size, shape, season, and time); the characteristics of the vegetation or habitat burned; and on species characteristics (e.g., size, mobility, habitat preferences). Modification of habitat, food, water sources, and cover would determine if a given species persists, thrives or declines in response to fire. Changes in vegetation structure and composition in the understory and overstory, as well as resultant changes in microclimates within and adjacent to burn units, will also affect wildlife species (McMahon and deCalesta, 1990).

The types of impacts to wildlife can be direct or indirect. Direct impacts include incineration, asphyxiation, injury, or avoidance of an area, and are most often experienced by less mobile species of life stages. Wildlife may also experience indirect effects. For example, fish or aquatic invertebrates can be harmed by sedimentation in a creek due to post-fire soil erosion, or carnivores can suffer from reductions in the prey base as a result of either direct mortality of the prey, or a reduction in the food and cover resources used by the prey species.

Habitat loss itself is a possible adverse indirect impact from fire, and can be short- or long-term. Changes in vegetation structure and composition, down and dead woody material, and snags that occur after the fire can all affect wildlife. In particular, the loss of down and dead woody material and snags during a prescribed burn remove essential structural habitat components for a variety of wildlife and reduces species diversity (McMahon and deCalesta, 1990). Depending on the season, a fire can also have adverse effects on a species' nesting or reproductive success. The nature of the fire, e.g., its severity, patchiness, whether it is a crown or understory fire, etc., will also determine if ground-dwelling or canopy-dwelling species are affected. If wildland fires burn extensive areas, and/or the fire is of high intensity, entire populations or subpopulations of wildlife can be affected.

Wildlife can also benefit from fire. For instance, populations of species dependent on early seral stage vegetation increase following a burn. Vegetation that grows in the first 2-10 years after a burn often contains higher levels of nitrogen, which can cause increases in some herbivore populations. Decreased cover can improve the growth of forage and can improve predator hunting success. Decreased parasite loads and increased dispersion in some species can diminish disease levels. Fire, depending on its severity, can either increase or decrease the availability of tree snags, which are used by many species for nesting, for shelter, and for foraging.

Fires that are patchy - those that result in a mosaic of burned and unburned or lightly burned areas - will maintain more heterogeneous environments with broader faunal diversity than will larger-scale, high-intensity fires that burn over large areas. Hot, stand replacing fires, which become more likely with increased fuel loads, will have entirely different impacts on the landscape and the fauna within it than will patchy or less intense fires. Intense hot fires can type change the vegetation, e.g., a forest to brush/grassland change after a severe fire can have a long-term adverse impact on fauna that thrive in dense forest habitat. Patchy low intensity fires do not

dramatically alter landscapes and remaining unburned vegetation provides habitat for existing species and impacts are relatively minor and short-term. Lack of fire and the resultant late seral stage vegetation will encourage species that thrive in such environments (see subsections on each class of wildlife below) at the expense of species favoring early or mid-seral habitats. Evidence suggests that maintenance of a variety of successional stages with patchy fire patterns ensures the highest levels of wildlife biodiversity (Nichols and Menke, 1984).

Invertebrates, Amphibians, and Reptiles

Direct lethal effects of fire on wildlife, in which animals are destroyed by incineration or asphyxiation are generally considered to be limited to smaller, relatively immobile species. In the Seashore, less mobile species include invertebrates, amphibians, and reptiles include the federal threatened red-legged frog. While most invertebrates that live in the surface soil layers and invertebrate eggs are likely to be killed by fire, some, including ants and flying surface insects, may increase in numbers after a fire. Fire may injure trees and encourage decay, attracting a variety of wood-boring insects that in turn attract insectivorous birds, such as woodpeckers.

Because amphibians and their eggs have evolved in moist environments and often require forest debris as habitat, fire impacts are a consequence of loss of litter and changes in water quality. Reptiles that occupy heat refugia during the day are usually not directly affected by fire. Along with reptiles, most amphibian populations show little response to mixed severity understory fires although species favoring open habitats are clearly favored in the first few years after a fire, before understory and shrub vegetation regenerates (USDA, 2000). The park has 28 species of reptiles and amphibians; however because the limited number of acres treated (500 acres prescribed burns; 500 acres of mechanical treatment under alternative A, the effect of the overall impact would be adverse, minor, and short-term. The impact to amphibians would be minor because effects would be localized and not burning riparian areas will provide protection zones, and impacts would be short-term because populations are expected to rebound within two years.

Fisheries and Aquatic Species

For fish, the primary concerns relative to fire are increases in water temperature and sediment, and the long-term loss of woody debris from stream channels. The most long-lasting and severe effects on fish habitat from fire occur when it is associated with the loss of streamside forest (McMahon and deCalesta, 1990). Of concern are the effects of burning in or near headwater channels that facilitate the transport of sediment and debris downslope into fish-bearing streams when stream networks expand during periods of high runoff.

Fire may affect the abundance and diversity of fish habitat and populations in streams by affecting the composition and structure of riparian vegetation and influencing water quality and quantity in a stream (McMahon and deCalesta, 1990). Loss of riparian vegetation can lead to elevated water temperatures, reducing the ability of the water to hold dissolved oxygen. The most susceptible species to these potential impacts are the federally listed coho salmon and steelhead trout. However, stream buffers of 100 feet would be left along creek areas to ensure impacts are mitigated to an acceptable level.

Birds

Because they are mobile, birds are usually affected only by changes in habitat following a fire, except during the nesting season, March 15 through July 15. Fire in California shrublands and forests have been shown to maintain or increase avian species diversity but to alter species composition. Some species, such as California quail, Swainson's thrush, scrub jay, and certain owls (northern spotted owl, see below) are known to decline in the first few years after fire (Lawrence, 1966, Lyon and Marzluff, 1985). Other species such as raptors, woodpeckers, and other owl species (burrowing, western screech) have been shown to increase in numbers after fires (USDA, 2000). Species adapted to early seral stages would clearly be favored. Ground - dwelling birds in the park such as California quail, northern harrier, and savannah sparrow - would be short-term negatively impacted by most fires while canopy-nesters such as red-tailed hawks, white-tailed kites, sparrow hawks, and ravens - would be negatively affected only by crown fires. Because prescribed burns are conducted primarily after the nesting season and regrowth occurs within months these impacts should be short-term and minor. Because snags are such an important determinant of avian diversity and abundance, the variable consequences of fire intensity and patterns on snag numbers would result in variable persistence of cavity nesters and those species which feed on wood-boring insects (USDA, 2000).

Mammals

Most mammals, because of their ability to escape the direct heat and smoke of fires, are only affected by the consequences of fire to vegetation, water and cover. During the first few growing seasons after a fire, improved vegetation growth usually provides increased food for herbivores (Ahlgren and Ahlgren, 1960). Reduced cover can provide increase risks for prey species, increased availability of seeds for small mammals and increased hunting opportunities for predators. Some species of rodents are known to decrease after stand-replacing fires, including the Western harvest mouse, brush mouse, and woodrat species (Schwilk and Keeley, 1998). Other species are known to increase after such fires including pocket gopher and deer mouse species (Sims and Buckner, 1973, Kaufman et al., 1988). Carnivores that depend on any of these impacted species would be similarly impacted. Ungulates often benefit from increased nutritional quality of recently burned vegetation, with positive impacts decreasing in five or more years post-burn. Fire may reduce disease rates in mammalian and avian populations by killing ground dwelling parasites and causing dispersion of individual animals, thereby reducing disease transmission (Peek et al., 1985). The park has 65 species of mammals from mountain lions, gray fox, brush rabbits, black-tailed deer, dusky-footed woodrats, deer mice, to pocket gophers and numerous species of bats. The majority of these species inhabit the four FMUs to be treated. Limantour FMU also has a small tule elk herd. Tule elk, brush rabbits, black-tailed deer, and other herbivores are expected to be positively impacted by fire and regrowth of vegetation. Dusky-footed woodrats, western harvest mouse shrews, and other small mammals are expected to have short-term impacts. Because the prescribed fires are cool, small areas that impacts are considered minor.

Alternative A

Under this alternative, 500 acres of prescribed burning and approximately 500 acres of mechanical treatment would occur over an average year. Treatment would be conducted within the Estero, Limantour Road, Highway One, and Bolinas Ridge FMUs. The only impacts to Tomales Point, Headlands, Inverness Ridge, Wilderness North, Wilderness South, and Palomarin FMUs would be from those actions common to all alternatives, such as road maintenance.

Analysis

For purposes of this analysis, the term wildlife includes fish and other aquatic species. The four primary activities associated with implementation of Alternative A, prescribed fire, wildland fire, fire suppression, and mechanical treatments can have adverse or beneficial impacts on wildlife, and these impacts can be direct or indirect. Impacts to wildlife are discussed primarily in terms of impacts to individuals, because the scale of the actions proposed within the plan are small enough that it is very unlikely that any wildlife populations or sub-populations would be affected. It is important to note, however, that unplanned large-scale wildland fire can affect populations as well as individuals, and from an ecological perspective, impacts to populations or subpopulations are considered more important than impacts to individuals.

Prescribed Fire

The primary use of prescribed burning under this alternative would be to reduce fuel loads along major road corridors to minimize unplanned ignitions, and to control non-native Scotch and French broom, as well as Monterey pine. No acreage would be burned to benefit wildlife, although in some cases burning may offer secondary benefits to wildlife. As noted above, fire can improve nutrient content of vegetation and restore habitat for some species of wildlife. It can also reduce the threat of catastrophic unplanned wildfire and the long-term destruction of habitat. Under Alternative A, prescribed fire would have beneficial, long-term, and minor impacts to some wildlife species from its effects in providing open or early seral stage habitat in areas of the Seashore most severely altered by fire suppression, and by continuing to reduce the risk of catastrophic fire, especially along roadways in the park. The benefits are no more than minor because the treated acreage would remain small, and would lie in large part along roadway corridors, where habitat is already disturbed by human activity and so is of lower quality for many species. Conversely, species that depend on down wood or dense forests, such as salamanders, some small mammals, and ground nesting birds would experience localized adverse impacts in the treated areas from displacement. Because only 500 acres would be burned and 500 acres are mechanically thinned, an abundant supply of down wood or more closed canopy woodlands would remain in the park, providing habitat for these species and preventing the impact to them of becoming more than negligible or minor and short-term.

Prescribed fires would be started when conditions are favorable for their control. This is often in spring or fall, which is outside of the dry season when most natural fires occur. This would have an adverse effect on species of wildlife that are adapted to the natural timing of fires, for example, small mammals that hibernate in leaf litter. Also, high levels of fuel loading in some

areas of the Seashore may cause prescribed fires to burn at higher than natural intensities, even when fire prescriptions are designed to minimize intensity. Both the unnatural seasonality, and in some cases intensity, of prescribed fires could result in greater direct lethal impacts for immobile or hibernating species (USDA, 2000), such as invertebrates, amphibians or small mammals, than under a pre-European natural fire interval. Again, because the area treated is small, impacts to these species in the park would be no more than minor.

The activities involved in controlling prescribed fires, such as hand line construction, snag removal, water drops, etc., can have short-term adverse effects on wildlife. Because they are similar to (but less intense than) activities associated with controlling unplanned ignitions, they are discussed below.

Unplanned Ignitions, Wildfire, and Suppression

Fire suppression activities, such as construction and use of staging areas, helispots, or spike camps; construction of firelines using hand tools or bulldozers; cutting of snags; and mop-up can have adverse effects on wildlife. Maintaining control of prescribed fires can also involve hand line construction, snag removal, water drops, and other actions, but such efforts are likely to be much less intense, and have less impact, than they would be during wildland fire suppression.

Small species of mammals, reptiles, or amphibians can be injured or killed when vehicles are accessing sites or staging areas, or when bulldozers are constructing line. It is anticipated that in most cases these impacts would occur infrequently. Removal or trampling of vegetation in temporary staging areas used for suppression activities could adversely affect wildlife until vegetation in such areas regrows. Noise, dust, and light emanating from suppression staging areas could affect the use of surrounding habitats by wildlife. Spills of fuel, oil, hydraulic fluid, antifreeze, and other toxic chemicals at staging areas could affect wildlife, especially those in aquatic environments. Personnel at fire camps or on suppression crews could provide a source of human food to wildlife, resulting in conditioning of wildlife and in human/wildlife conflicts. These activities and the impacts they cause are discussed in greater detail below.

Dropping water or retardants on fires from helicopter buckets could result in a variety of impacts to wildlife. Water removed from small water bodies could have temporary seasonal impacts on aquatic organisms by reducing the size of wet or wetland habitat, or more serious and possibly permanent impacts on the inhabitants if the pond is completely drained or dried prematurely.

Transfer of water from one area to another can also have impacts to wildlife. For example, in the Sierra Nevada, chitrid fungus has been identified as a factor in the disappearance of mountain yellow-legged frog populations. Federal land management agencies in the region have expressed concern that helicopter buckets dipping in separate water bodies could add to the problem by spreading the fungus to currently non-infected populations of frogs. In Point Reyes, the use of several water bodies to fight a wildfire could result in the spread of non-native bullfrogs, which prey heavily on native frog species, or contribute to the spread of unknown pathogens or other exotic species.

The physical impact of a water drop could adversely affect individual animals through crushing. One advantage of water drops is in their use in some circumstances, instead of hand lines ("wet-lining") to control fire movement. This tactic would result in less impact to soil, forest litter, and vegetation than hand line construction and, therefore, would have less impact on wildlife, both in intensity and duration. Under Alternative A, the impact of water drops on wildlife would be adverse, long-term, and minor based upon possible impacts to aquatic ecosystems, especially in relation to amphibians. The potential impact is minor because the historic occurrence of unplanned ignitions has been only three per year and most do not involve water drops. However, if they did occur, the impact would be limited to a relatively small area. Water drops are not used in prescribed fire activities at the park.

Retardant drops have the same potential for physical injury, but may also be toxic, particularly in aquatic habitats. Studies have shown that the ecological effects of retardant and fire Suppressant Forms can be adverse to algae, aquatic invertebrates, and fish (Hamilton et. al., 1996). The low-flying aircraft could also disturb wildlife. Under Alternative A, impact to wildlife from retardant drops is expected to be negligible, adverse, and short-term because of its limited application in the park, and protocols for its use designed to protect aquatic resources.

Construction of helispots can result in the felling of trees and snags, which are potential wildlife habitat. Snags are especially important wildlife habitat. In addition, helicopter traffic would likely disturb wildlife, such as nesting raptors. Under Alternative A, the impact of helispots on wildlife is expected to be adverse, long-term, and minor, based upon their likely very limited use (if at all). With mitigation, limiting helispot construction and site helispots away from sensitive resources can reduce these impacts.

Fire crews staying in spike camps can have an adverse effect on wildlife by allowing them access to human food. This would lead to wildlife becoming conditioned to human foods and could result in human-wildlife conflicts. In such cases, animals often must be killed to protect human safety. Presence of hand crews in more remote areas would introduce an element of disturbance, which could affect sensitive species, such as nesting raptors. Under Alternative A, impacts to wildlife from spike camps are expected to be adverse, short-term, and minor. However, placing site spike camps away from sensitive resources and providing strict control of availability of food to wildlife at camps can reduce these impacts. Since spike camps are rarely used for prescribed fire activities, impacts are going to be adverse, short-term, and negligible.

Hand line construction would remove and disturb soil and forest litter, possibly affecting animals such as small mammals, amphibians, invertebrates, and ground-nesting birds. The presence of hand line crews in remote locations could cause direct disturbance of some wildlife species and introduce unnatural food sources (see spike camps above). Removal of forest litter and vegetation can also lead to soil erosion and increased siltation in adjacent lakes and streams. This could have an adverse effect on aquatic species, including invertebrates, amphibians, and fish. Impact of hand line construction in association with managed wildland fire and prescribed fire under Alternative A would be adverse, short-term, and negligible given the present limited amount of wildland fire and the limited use for prescribed fire (most line is cut by mowing only for prescribed fire).

Snags are an extremely valuable tree-form to some wildlife (Brown and Bright, 1997). They provide cavities and loose bark for nesting and roosting and food in the form of wood-boring insects. Any holding action that requires the felling of snags to protect human safety and the integrity of the fire line would potentially affect wildlife by reducing the availability of snags to species such as pileated woodpeckers and several bat species. Felling would likely kill some animals. The number of snags lost would vary, depending upon factors such as the type and age of tree stand, its history of fire and/or disease or insect infestation, and the intensity of the fire. Under Alternative A, snagging associated with holding actions for wildfires would potentially have minor, long-term, and adverse impacts because of the relatively small areas that would be affected (30 acres average per year).

Mop-up, or the churning of soil and forest litter to extinguish residual hot spots along the periphery of a fire, would cause some mortality of buried organisms by exposing them to heat and flames. Such impact, however, would be along short sections of the lined perimeter and affect few species. Impact of mop-up would therefore be adverse, short-term, and negligible for both prescribed burn and wildfires.

Mechanical Treatments

Mechanical fuel reduction techniques, such as mowing or brush clearing, can have adverse impacts on wildlife. Local mechanical treatments may affect ground-dwelling or brush-dwelling species by direct mortality or injury to individuals or their eggs, or by altering cover and food sources. Brush clearing can also increase foraging opportunities for some herbivores and predators.

Hand cutting of understory vegetation, down fuels, and small-diameter trees in the wildland/urban interface would have mixed effects on wildlife and habitat. Hand cutting trees and brush to attain target conditions provides a less woody and more natural habitat and helps reduce the threat of catastrophic fire; especially from human-caused ignitions that occur in developed areas. For a few species, such as ground and understory nesters and rodents, the loss of low-lying cover and more dense brush or small trees may have temporary impacts. However, other canopy nesters, avian predators, and several bat species would remain unaffected or benefit from a more open forest habitat. This type of habitat is less common in the park because of a history of fire suppression and fuel build-up. Creating more of it might result in species requiring this type of habitat moving into the thinned forests, with possible overall increases in species diversity in the area. Because no more than 500 acres per year are to be treated mechanically under Alternative A, the extent of adverse impacts to wildlife living in more densely wooded lands is likely to be negligible and short-term. If the same areas continue to be mechanically treated, the impact would be long-term. Negligible benefits would result to wildlife species requiring open habitats. Additional negligible benefits from a reduction in the risk of catastrophic fire in the treated area would also result from this alternative.

Short-term adverse impacts to wildlife during hand-thinning and mowing operations include human presence and use of chainsaws and other tools during thinning operations. Chipping would have the same effects. These actions may disturb wildlife, although such disturbance would be short-lived and negligible.

When removed biomass cannot be burned on site or removed for logistical, administrative, or ecological reasons, it may be chipped and distributed over the site. When chips are spread deeply enough to affect the growth of native plants, wildlife would be adversely affected. Such impacts, however, would be limited to areas adjacent to roads and developed areas, and standard mitigation for chipping calls for chips to be spread as thinly as possible on the site - usually to a depth of not more than 1 inch. Impact to wildlife from chipping would therefore be negligible, adverse, and short-term

Piling and burning of downed trees and shrubs may have an adverse effect on some wildlife. Some species, such as small rodents and reptiles, may take up residence in burn piles between the time they are stacked and the time they are burned; which can be several months. Many of these animals are likely to escape fire once the piles are ignited, but some may perish.

Fire Information/Education

Impacts associated with fire information and education would largely be indirect, beneficial, although highly dependent on the nature of the fire management action. Pre-planned events such as prescribed fires and mechanical treatment provide the opportunity to demonstrate the effectiveness of natural resource management to local communities and the interested public. During unplanned events, such as wildfires, time for effective communication is often more limited and can be more controversial since resources are often damaged. However, the effects of education usually do not have a direct effect - positive or negative - on impacts to wildlife. In some cases, education can be used to enforce a closure of an area to ensure wildlife quickly recovers.

Fire Cache/Park Headquarters Relocation, and Construction

The construction of a fire cache at Bear Valley would have no influence on the direct effects of fire management actions on wildlife. However, relocating fire management personnel to a more centralized location would allow for faster response time to natural resources in the event of wildfires.

No adverse or beneficial indirect effects are anticipated with the construction of the new fire cache. The building site is in the main developed area of the park at Bear Valley and heavily impacted. The site is a former trailer pad that was recently removed. There may be some short-term, adverse, negligible impacts to wildlife caused by noise during the construction.

Fire Effects and Fuel Management Research

No adverse or beneficial effects are anticipated on wildlife from the implementation of Alternative A research projects.

Cumulative Impacts

Cumulative impacts to wildlife could occur from construction or compaction from activities described in Appendix C, or from a large-scale wild fire. When considered in combination with the minor to moderately adverse impacts of projects (except a large-scale fire) listed in Appendix C, the cumulative impacts from Alternative A would be adverse, short-term, and moderate. When the effects of a large-scale fire such as the 1995 Vision Fire and the high levels of fuel loading from lack of fire over the last 150 years, some areas in a large-scale wildfire may burn at higher than natural intensities. This could create extensive forest gaps, discontinuous habitat, and greater consumption of large woody debris than what would be expected under natural fire conditions. In addition, there would be a type conversion of habitat in some areas - forest to brush/grassland and some long-term loss of forest habitat. This change to habitat could have short-term major adverse impacts or long-term moderate impacts to wildlife in the burned area. For example, the Vision Fire had a major adverse effect on mountain beaver, but the population is slowing recovering (Fellers, 2003)

Extensive burned areas that may be continuous from ridgeline to slope bottom and include riparian areas also characterize high-severity fires in Point Reyes. In addition, sediments loads would be expected to be at least twice the normal load under normal natural conditions (Ketcham, 2003). The sediment loads and lack of riparian vegetation would have adverse, moderate, long-term impacts (more than two years) to fish and aquatic species. However, vegetation would return in the long run, as it has following the 12,000+ acre Vision Fire, and erosion overland flow would return to rates within the natural rate of variability, preventing long-term impairment of park resources.

In summary, suppression impacts from a large fire would be adverse, moderate, and long-term. Changes to habitat would have an adverse, long-term, moderate to major effect on wildlife, but negative effects would be reversed in the long-term.

Conclusions

Under Alternative A, prescribed fire would have a beneficial, short- or long-term minor impact on wildlife by creating more open habitat and reducing the risk of catastrophic fire. A similar adverse, short-term minor impact on species using existing down wood or dense forest habitat is also likely.

Mechanical treatment would also offer short- to long-term negligible benefits to wildlife species requiring early seral stage habitat, and have adverse short- to long-term negligible impacts on some forest dwelling wildlife. The machinery used for chipping and shredding would be loud, which would have negligible, short-term impacts to some species, such as nesting birds, through disturbance.

Some suppression activities or actions to control prescribed burns, such as spike camps, access or creating fire lines, would have short-term adverse and therefore minor impacts on wildlife. Others, such as creating helispots or the use of helicopter buckets of water or retardants, may

have longer lasting impacts. Overall, these activities are not expected to have more than minor impacts to wildlife. Actions to suppress large fires would likely be more intense, with short-term major or long-term moderate adverse impacts to wildlife.

No impairment to park wildlife would occur from implementing Alternative A.

Alternative B

Analysis

Prescribed Fire and Suppression

In this alternative 1000 acres of prescribed burning would occur over an average year. As in Alternative A, the primary purpose of burning would be to reduce fuels and the chance of a catastrophic wildfire. Wildlife would therefore primarily be the recipient of secondary benefits related to the creating of early seral stage or more open habitat, which is now quite rare, or of a reduced risk of large-scale unplanned fires. However, Alternative B would also include some small-scale test burns in Douglas-fir and Bishop pine forests to determine the effects. This may later lead to larger-scale prescribed burns and improved habitat in these heretofore untreated areas, with additional benefits for wildlife native to these forests. In addition, Alternative B includes burning in the Palomarin fire management unit to control the encroachment of Douglas-fir forest on what is now coastal scrub habitat in the Point Reyes Bird Observatory field station. This would help continue to maintain a mosaic of habitat for a variety of bird species, and should improve both habitat and species diversity, a moderate localized benefit to wildlife relative to Alternative A, but negligible or minor benefit relative to the entire study area.

As in Alternative A, prescribed fire would have a beneficial, long-term, minor impact on wildlife compared to the entire study area because this action provides habitat improvement in areas where natural fire cycles have been severely restricted by fire suppression and some reduction in the risk of catastrophic fire. When compared to the entire study are, the effects are comparatively minor because benefits are limited by the relatively small number of acres (1000) treated. Also, because the burn units are dispersed throughout the park in the various FMUs (no concentration of impacts within a watershed and only 10% or any watershed would be treated annually), the total acres treated in relationship to the 90,000 acres within park boundaries is still relatively small (approximately 1%).

However, the number of acres treated and resulting benefits to wildlife would be twice those of Alternative A. In addition, Alternative B treats acreage in four more FMUs - Inverness Ridge, Wilderness North, Wilderness South, and Palomarin - not treated in Alternative A. As noted above, compared to the entire study area or entire park, benefits are minor. But, compared to beneficial impacts resulting from the 500 acres burned in the No Action alternative, Alternative B could offer moderate short- to long-term positive impacts to wildlife.

Fire suppression activities and those needed to maintain control of prescribed fires would result in the same types of direct and indirect impacts described above for Alternative A. These include injury or death from heavy equipment or vehicles accessing a site; removing vegetation for

staging areas or hand lines; noise, dust, and light from staging areas; accidental spills of fuel or other chemicals; the use of helicopter drops of water or retardants; noise from low flying aircraft or helicopters; and the construction of helispots. Fire crews occupying an area would also disturb wildlife and could result in the conditioning of some individual animals to the presence of humans. Indirect impacts would also be similar to those described above for the No Action alternative, and could include increased erosion of soil and siltation of lakes or streams and the loss of snags as habitat.

Although these adverse effects on wildlife from prescribed fire would occur over 1000 acres, they would remain minor and short-term in the context of the entire study area. However, they may be quite noticeable on a localized basis, and compared to the No Action alternative, may be locally moderate.

As in Alternative A, suppression actions from small-scale wildfires would potentially have minor, long-term, and adverse impacts because of the relatively small areas that would be affected. The impacts are identical to Alternative A as the acreage of wildfires that the park suppressed in an average year is not expected to change.

Mechanical Treatments

Under Alternative B, the total acres treated by mechanical means would increase to 1000. No mechanical thinning specifically to benefit wildlife would be undertaken; therefore benefits or adverse impacts from mechanical treatment would be related primarily to the increased acreage treated. Although twice the acreage as in Alternative A would be thinning, this is still a relatively small (approximately 1%) percentage of the 90,000 acres in the study area. In addition, treatment would be dispersed among seven FMUs (Alternative A would include mechanical treatment in three FMUs). The FMUs to receive additional treatment over Alternative A are Tomales Point, Wilderness North, Wilderness South, and Palomarin. Although this may provide some additional benefits to the tule elk population in the Tomales Point FMU, in the context of the entire study area, benefits to wildlife from mechanical treatment would likely be short- to long-term (depending on whether the same areas would be routinely treated) and negligible to minor.

The secondary benefits of clearing down wood or thinning branches to those species requiring more open habitat could be much more noticeable in some locations and compared to these same benefits in Alternative A. This is also true of adverse impacts associated with the thinning activities themselves, as well as from the loss of dead logs or other habitat for forest dwelling species. Either localized benefits or adverse impacts could range from minor to moderate compared to those related to Alternative A.

Fire Information/Education

As in Alternative A, the impacts associated with fire information and education would largely be indirectly beneficial, although highly dependent on the nature of the fire management action.

Fire Cache/Park Headquarters Relocation, and Construction

As in Alternative A, the construction of a fire cache at Bear Valley would have no influence on the direct effects of fire management actions on wildlife. There may be some short-term adverse, negligible, impacts to wildlife caused by noise during the construction.

Fire Effects and Fuel Management Research

No direct adverse or beneficial effects are anticipated on wildlife from the implementation of Alternative B research projects. However, depending on the results, test burns may result in the creation of additional open or early seral stage habitat in Douglas-fir or Bishop pine forests.

Cumulative Impacts

No cumulative impacts beyond those described for alternative A would occur.

Conclusion

In the context of the 90,000 acre study area, the impacts to wildlife of Alternative B would be nearly indistinguishable from Alternative A. Treatment with prescribed fire and through mechanical means would result in short- to long-term, negligible to minor benefits to wildlife from the reestablishment of the natural fire cycle, reduction of fuel loads, and reduction of the potential for catastrophic wildfire. However, compared to No Action, Alternative B could offer moderate short- to long-term benefits to wildlife because twice as many acres would be treated (2000 total; 2% of total acres managed) and noticeable on a local scale. Forest dwelling species would suffer negligible to minor short-term adverse impacts from reductions in habitat overall, and minor to moderate impacts relative to those from the No Action alternative.

Some suppression activities (retardant use) or actions to control prescribed burns, such as spike camps, access or creating fire lines, would have short-term adverse and therefore minor impacts on wildlife. Others, such as creating helispots or the use of helicopter buckets of water or retardants, may have longer lasting impacts. Overall, these activities are not expected to have more than minor impacts to wildlife. Compared to Alternative A, the degree of impact from actions to prepare for or control prescribed burns would be greater. Since all of these actions are those associated with short-term, more controlled minor impacts, it is unlikely that more than moderate adverse impacts compared to Alternative A would occur. As in Alternative A, actions to suppress large fires would likely be more intense, with short-term major or long-term moderate adverse impacts to wildlife.

In the context of the entire study area, Alternative B would result in negligible to minor short- to long-term benefits to wildlife from creating open habitat using mechanical thinning. Compared to Alternative A, these benefits could be moderate.

No impairment to park wildlife would occur from implementing Alternative B.

Alternative C

Analysis

Prescribed Fire and Suppression

In this alternative 2000 acres of prescribed burning would occur over an average year. To the extent it is possible, prescribed burns would be conducted to approximate historic natural fire intensity and fire intervals. The intent is to allow the process of fire to act on the landscape as it has for thousands of years to the greatest extent possible, while ensuring human safety and protecting property. In both Wilderness North and Wilderness South fire management units, prescribed fire would be used to open up forested areas to increase forage for herbaceous wildlife. The goal under Alternative C is to reintroduce fire into forests in these FMUs that have historically burned on a regular basis (estimated fire return interval: 7-14 years), but which have not burned for 50-100 years. Fire would be used in the Tomales Point FMU to encourage the growth of native plant species, with expected positive effects on the Tule elk population in the area. Fire would also be used to help control non-native and highly invasive velvet grass in this FMU. As in Alternative B, prescribed burning in the Palomarin fire management unit would be used to maintain and improve habitat for a variety of bird species. Beyond these specific changes, Alternative C would simply treat a greater number of acres with the intent of reducing fuels and controlling non-native and invasive plant species than either of the other alternatives. As noted in the analysis of these alternatives, wildlife would experience benefits from these activities even though they are not specifically directed at improving wildlife habitat. These benefits include creating more open habitat, increase nutrition in forage, an emphasis on native plant species, some of which are likely to have been food for native wildlife species, and a decreased risk of large-scale catastrophic fires.

In this alternative, prescribed fire would have a beneficial, short- to long-term moderate impact on wildlife compared to the entire study area even compared to the entire study area. The effects would be noticeable because 2000 acres would be treated, and because the goal of this alternative is to return as much of the park's fire dependent vegetation as possible (given no more than 2000 acres per year would be treated) to its natural fire interval and intensity. As in other alternatives, burn units would be dispersed throughout the park in the various FMUs (no concentration of impacts within a watershed and only 10% or any watershed would be treated annually) and the total acres treated in relationship to the 90,000 acres within park boundaries would be relatively small (approximately 2%).

In another context, that is, related to the benefits of prescribed fire in the No Action alternative, Alternative C would treat four times the area. This combined with the focus of Alternative C on improving conditions for natural resources could result in major benefits on a local scale compared to Alternative A. If the treated areas are eventually returned to their natural fire cycles, wildlife may experience very long-term or permanent positive impacts.

Fire suppression activities and those needed to maintain control of prescribed fires would result in the same types of direct and indirect impacts described above for Alternative A. These include injury or death from heavy equipment or vehicles accessing a site; removing vegetation for

staging areas or hand lines; noise, dust, and light from staging areas; accidental spills of fuel or other chemicals; the use of helicopter drops of water or retardants; noise from low flying aircraft or helicopters; and the construction of helispots. Fire crews occupying an area would also disturb wildlife and could result in the conditioning of some individual animals to the presence of humans. Indirect impacts would also be similar to those described above for the No Action alternative, and could include increased erosion of soil and siltation of lakes or streams and the loss of snags as habitat.

These activities would occur on 2000 acres per year, and may result in moderate adverse impacts, even in the context of the entire study area. On a localized basis, the impacts may be quite noticeable, and compared to the No Action alternative, may be moderate or even major in their intensity. Actions associated with controlling prescribed burns are likely to have less intense impacts of shorter duration than those needed to suppress wildfires. Construction of helipads or the use of helicopter drops for water or retardants could have long-term and more severe effects on wildlife.

Mechanical Treatments

Under Alternative C, the total acres treated by mechanical means would increase to 1,500. No mechanical thinning specifically to benefit wildlife would be undertaken; therefore benefits or adverse impacts from mechanical treatment would be related primarily to the increased acreage treated. Although three times the acreage as in Alternative A would be thinning, this is still a relatively small (approximately 1.5%) percentage of the 90,000 acres in the study area. In addition, treatment would be dispersed among the same eight FMUs as in Alternative B (Alternative A would include mechanical treatment in three FMUs). As in Alternative B, the Tomales Point FMU would receive thinning treatment, which may offer specific benefits for tule elk by improving the quantity and quality of forage available. Otherwise, the same type of benefits as described in the other alternatives of creating more open habitat and reducing the risk of catastrophic fire would occur if this alternative were selected. Because more acreage would be treated, benefits are likely to be minor to moderate. If treated areas continue to be treated, the benefits would be long-term.

The secondary benefits of clearing down wood or thinning branches to those species requiring more open habitat could be much more noticeable in some locations and compared to these same benefits in Alternative A. This is also true of adverse impacts associated with the thinning activities themselves, as well as from the loss of dead logs or other habitat for forest dwelling species. Either localized benefits or adverse impacts could be moderate compared to those related to Alternative A.

Fire Information/Education

As with other alternatives, fire information and education would largely be indirect and beneficial, although highly dependent on the nature of the fire management action.

Fire Cache/Park Headquarters Relocation, and Construction

As in other alternatives, construction of a fire cache at Bear Valley would have no influence on the direct effects of fire management actions on wildlife. There may be some short-term, adverse, negligible impacts to wildlife caused by noise during the construction.

Fire Effects and Fuel Management Research

No direct adverse or beneficial effects are anticipated on wildlife from the implementation of Alternative C research projects. However, depending on the results, test burns may result in the creation of additional open or early seral stage habitat in Douglas-fir or Bishop pine forests.

Cumulative Impacts

No cumulative impacts beyond those described for alternative A would occur.

Conclusion

Treatment with prescribed fire and through mechanical means would result in short- to long-term, minor to moderate benefits to wildlife from the reestablishment of the natural fire cycle, reduction of fuel loads, and reduction of the potential for catastrophic wildfire. However, compared to No Action, Alternative C could offer moderate to major short- to long-term benefits to wildlife because four times as many acres would be treated (2000 total; 2% of total acres managed) and be noticeable on a local scale. Forest dwelling species would suffer minor to moderate short-term adverse impacts from reductions in habitat overall, and moderate or even major localized impacts relative to those from the No Action alternative.

Some suppression activities (retardant use) or actions to control prescribed burns, such as spike camps, access or creating fire lines, would have short-term, adverse, and therefore minor impacts on wildlife. Others, such as creating helispots or the use of helicopter buckets of water or retardants, may have longer lasting impacts. Overall, these activities are not expected to have more than moderate impacts to wildlife. Compared to Alternative A, the degree of impact from actions to prepare for or control prescribed burns would be greater. Since all of these actions are those associated with short-term, more controlled impacts, it is unlikely that more than moderate adverse impacts compared to Alternative A would occur. As in Alternative A, actions to suppress large fires would likely be more intense, with short-term major or long-term moderate adverse impacts to wildlife.

In the context of the entire study area, Alternative C would result in minor short- to long-term benefits to wildlife from creating open habitat using mechanical thinning. Compared to Alternative A, these benefits could be moderate.

No impairment to park wildlife would occur from implementing Alternative C.

IMPACTS ON SPECIAL-STATUS SPECIES

Alternative A

The project area contains numerous plant and wildlife species that are nationally, regionally, or locally rare. These species span a spectrum of rarity from being federally listed as Endangered or Threatened under the Endangered Species Act, to being recognized by the California Native Plant Society (CNPS) or local area species experts as uncommon or rare. For purposes of this document, all of these species are collectively referred to as "special-status species." These species all require consideration when management actions are taken to ensure that actions do not harm the species or their habitats.

Fire management activities have potential to affect many of these species. For example, stream or riparian species could be adversely affected by increased sedimentation in creeks and/or persistent turbidity following wildland or prescribed fire. Fire management activities such as cutting fire line or removing vegetation to reduce fuel accumulations could destroy or harm individuals or damage their habitat. Conversely, as is the case for common plants and wildlife, many special-status species in the project area are adapted to periodic fire, and application of fire to the ecosystems could benefit these species by providing a wider diversity of habitats, by stimulating seed germination, or by improving habitat for prey species.

In May 2001, in response to PRNS's request to initiate consultation on revision of the park's fire management plan, the U.S. Fish and Wildlife Service sent a list of Federally-listed Threatened and Endangered animal and plant species that may occur in the Project Area (dated 5/24/01). The following tables of special-status species (see Affected Environment) were generated from the USFWS list, from State of California lists, and from California Native Plant Society lists to facilitate this impact analysis:

Table 15. Federal Threatened, Endangered, Candidate, and Proposed plant species that may occur in areas affected by PRNS's Fire Management Plan

Table 21. Federal Plant Species of Concern and California-listed plant species that may occur in areas affected by PRNS's Fire Management Plan

Table 22. Additional Plant Species of NPS Management Concern known to occur in areas affected by PRNS's Fire Management Plan.

Table 24. Federal Threatened, Endangered, Candidate, and Proposed animal species that may occur in areas affected by PRNS's Fire Management Plan

Table 33. Federal Animal Species of Concern and California-listed animal species that may occur in areas affected by PRNS's Fire Management Plan

These tables present summary information on whether or not the species are known to occur in PRNS and/or GGNRA and whether or not they are likely to be adversely impacted by fire

management plan activities, based on PRNS's best professional judgment. Species listed in these tables were evaluated to determine whether or not fire management activities could affect either individuals of the species or their habitat.

Federally listed Threatened and Endangered Species Covered in this EIS

The following sections discuss probable impacts to species listed as threatened or endangered by the federal government that may occur from implementing actions in the fire management plan alternatives. All plant or animal species on this list and present in the project area were considered in the analysis.

PLANTS
Sonoma alopecurus (*Alopecurus aequalis var. sonomensis*)
Sonoma spineflower (*Chorizanthe valida*)
Tiburon paintbrush (*Castilleja affinis ssp. neglecta*)
Marin dwarf flax (*Hesperolinon congestum*)
Beach layia (*Layia carnosa*)
Tidestrom's lupine (*Lupinus tidestromii [var. layneae])*

WILDLIFE
Northern spotted owl (*Strix occidentalis caurina*)
California red-legged frog (*Rana aurora draytonii*)
Central California coho salmon (*Oncorhynchus kisutch*)
Central California Coast steelhead (*Oncorhynchus mykiss*)
California freshwater shrimp (*Syncaris pacifica*)
Myrtle's silverspot butterfly (*Speyeria zerene myrtleae*)
Western snowy plover (*Charadrius alexandrinus nivosus*)

Federally Listed Plants

For each federally listed plant species, Table 52 summarizes the most current information on the number of occurrences of the species in the project area and the population size trend that PORE botanists have estimated from available data. Narratives on each species status, potential impacts, and impact mitigation measures are presented following the table.

Table 52. Number of Occurrences and Estimated Population Trends for Listed Plant Species in the Project Area

Species	# of Occurrences in Project Area	Population Trends
PRNS		
Sonoma alopecurus (E) *Alopecurus aequalis var. sonomensis*	4	Unknown – need more data
Sonoma spineflower (E) *Chorizanthe valida*	2	Stable or increasing
Beach layia (E)	13	Stable

Layia carnosa		
Tidestrom's lupine (E)	7	Stable
Lupinus tidestromii (var. *layneae*)		
North District GGNRA		
Tiburon paintbrush (E)	1	Stable
Castilleja affinis ssp. neglecta		
Marin dwarf flax (T)	6	Increasing
Hesperolinon congestum		

a/ Population size trends are based on very limited data as described in the following sections.

Sonoma alopecurus (Alopecurus aequalis var. sonomensis) – Endangered
Sonoma alopecurus, a perennial grass that grows in the park on pastures in agricultural areas, favors moist or wet sandy soils. Results of monitoring at the Seashore suggest it thrives in wetlands that are grazed just enough to reduce competing vegetation. New occurrences of alopecurus may be found in areas of seasonally saturated soils as rare plant surveys continue. Such areas are most common in, but not exclusive to, the relatively gentle topography of the west-central Point Reyes peninsula.

As noted in Affected Environment, the four known locations of this species consist of populations ranging from about 600 to more than 8000 individuals. The G Ranch population is located in a back dune area near the southwest corner of Abbott's Lagoon, in a swale that supports freshwater marsh vegetation. As of 2000, a systematic survey found a peak population size of over 1,500 individuals. By 2003, the population had increased to over 8,000. The H Ranch population is in a freshwater marsh/swale along a fence that borders an ungrazed area south of Abbott's Lagoon. Immediately above a small berm carrying the trail across the swale is a population that numbered 60 in 2000, but which has now grown to more than 600 plants. A third population of 50+ plants on F Ranch was discovered in 2000 in a wetland swale between semi-stabilized dunes. In 2003, this population numbered more than 1000. The fourth population exists on a 521 acre tract recently purchased by the NPS from AT & T and currently leased for cattle grazing. Two patches occur on this tract, and together they numbered over 3,500 plants when last surveyed in 2003.

The long-term population trend for this species is unknown, as two of the populations were recently discovered, and more intense monitoring and surveying of the remaining two populations was not completed until 2000. Additional monitoring over time of these populations, and a broad based survey of the study area for as yet undiscovered populations is needed to know whether the population park-wide is stabilized, or is increasing or decreasing in size. However, in the short-term all four populations have increased from the year 2000 to 2003.

Because all known populations of Sonoma alopercurus in the park lie within the Minimum Management Fire Management Unit (a former population in the Palomarin FMU has been extirpated), they would not be subject either to prescribed burning or mechanical fuels treatments. The populations could be adversely affected by an unplanned wildfire or by suppression activities associated with such a fire, but this is considered unlikely given they occur in wet sites within pastures routinely grazed by cattle where fire is unlikely to carry.

Sonoma spineflower (Chorizanthe valida) – Endangered
Sonoma spineflower was thought to have been extirpated in Marin and Sonoma counties from agricultural and residential development, but was rediscovered in the park in 1976 in the same pasture on G Ranch in which Sonoma alopecurus is located. Coarse estimates of size indicate this population size has grown from several hundred plants in 1983 to 30,000 plants in 1993. The Marin Chapter of California Native Plant Society has actively searched other areas for this plant since its 1980 rediscovery without success, and it is considered unlikely that other populations of spineflower would be found.

As noted in Affected Environment, the park has attempted to establish new populations by seeding grazed pastures in several locations in the park. To date, one population has been successful, and a second appears to be taking hold. Overall, the population in the park appears to be stable and increasing.

As with Sonoma alopecurus, all known populations of Sonoma spineflower are growing in the Minimum Management Fire Management Unit, where no fire management activities are planned. Although it is possible they could be subject to impacts associated with an unplanned wildfire or its suppression, it is considered unlikely given their location in a wet and low fuel (e.g., grazed) environment.

Tiburon paintbrush (Castilleja affinis ssp. neglecta) – Endangered and Marin dwarf flax (Hesperolinon congestum) – Threatened
Both Tiburon paintbrush and Marin dwarf flax are species that grow in the serpentine soils and rocky outcrops of Nicasio Ridge at the northern border of GGNRA's North District. Tiburon paintbrush is a semi-woody perennial; recent data suggests the population may be in decline (see Table 17). Marin dwarf flax has been found in six locations on Nicasio Ridge, and overlaps at one point with Tiburon paintbrush in and near the McIsaac Ranch. The abundance of Marin dwarf flax on Nicasio Ridge varies from year to year, and new populations were found in 1999 and 2000. This suggests the distribution of Marin dwarf flax on Nicasio Ridge is not fully known, and that it may appear in other sites in the future due to seed dispersal, weather, or localized disturbances.

All of the occurrences of Marin dwarf flax and Tiburon paintbrush are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuels treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur on rocky outcrops where fire is unlikely to carry.

Beach layia (Layia carnosa) – Endangered and Tidestrom's lupine (Lupinus tidestromii) – Endangered
These two plant species occur in coastal dunes on the western edge of the PRNS peninsula. Both have been monitored by CNPS volunteers and PRNS staff since the 1980s. Monitoring reports include an estimate of plant numbers, a description of site characteristics, and apparent threats to each occurrence. These reports have been assembled in the PRNS Rare Plant Database.

Beach layia has been recorded at both dune and pasture sites in the park. Its habitat is the central foredune community, which, because of dune blowouts and restabilization, can cause large fluctuations in plant numbers and local distribution. Table 19 in Affected Environment shows this is true for populations in the park. Some patches of beach layia in the park are considered threatened by the presence of non-native invasive species such as European beachgrass (*Ammophila arenaria*), sea fig (*Carpobrotus chilensis*), and/or Hottentot fig (*Carpobrotus edulis*) nearby.

Tidestrom's lupine also occurs in seven dune and pasture sites in the park. The largest population at the Seashore is located behind dunes southwest of Abbott's Lagoon. Others are located north of Abbott's Lagoon and further south, near the North Beach parking area and the Old Lifesaving Station. Three of the seven occurrences in the park are located in pastures, but as with beach layia, grazing is not considered a threat to their continued existence. Six of the populations are considered threatened by European beachgrass and ice plant. The total number of individuals has increased in the last three years, from an estimated 8,000+ in 2000 to nearly 200,000 in the year 2002. The population is considered stable.

All of these occurrences are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuels treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur in sandy dunes surrounded by pastures routinely grazed by cattle where fire is unlikely to carry.

Other Special Status Plant Species

Table 21 in Affected Environment (of all plant species) shows several plant species in the affected area are listed as federal Species of Concern. Species of Concern are those where USFWS is collecting additional information to determine whether they warrant consideration for future listing. In addition, three species (Point Reyes blennosperma, Marin Manzanita, and Bolinas ceanothus) are considered rare by the state of California, one is state endangered (Point Reyes meadowfoam) and all plant species in the table have been watchlisted by the California Native Plant Society. In Alternative A, although no federal or state listed species have been found in FMUs that would be treated with prescribed fire, one state rare species (Bolinas ceanothus) is present in the Bolinas Ridge FMU. Bolinas ceanothus does not occur in any FMUs slated for mechanical treatment in this alternative. Several federal species of concern are present in Estero and Limantour Road FMUs, which would be treated with both prescribed fire and mechanical thinning. Because these species are not listed or proposed for listing as threatened or endangered by the state or federal government, they are treated together below.

Analysis

Under Alternative A, 4 FMUs - Estero, Limantour, Highway One, and Bolinas Ridge - are treated with prescribed fire. Three of these - Estero, Limantour, and Highway One FMUs - would also be treated mechanically.

Prescribed Fire

The effects of fire on the species listed in Table 21 are not fully known. However, the park's mean surface fire intervals of 7 to 13 years (Brown et al., 1999) indicate fire is an integral part of the natural ecosystem at Point Reyes. Research has demonstrated that fire plays a critical role in the management of many threatened and endangered species in areas with regular burn intervals. For example, fire helps maintain open areas, can stimulate or is required for reproduction, and removes non-native competitors. Ceanothus, for example, is most often a fire dependent genus. Even though individuals of some species of concern may be killed by prescribed fire, the removal of competitors has a long-term beneficial effect as fire dependent native species return, while the competitors often do not (National Biological Service, 1995).

Because prescribed fire would be limited in scope, it would not involve a large component of the total population of each species of concern. This means both the potential for adverse or beneficial impacts would be no more than minor. Adverse impacts would be short-term for the most part, but beneficial impacts may be long-term.

Unplanned Ignitions, Wildfire, and Suppression

Wildland burns may have the same type of effects as prescribed burning, but may also cause type conversions or help facilitate the spread of exotic species. Suppression activities during a wildfire would also potentially result in crushing, shearing, or destruction of unburned individuals of some of the species listed in Table 21 or indirect effects on these same species through soil compaction. The average acreage burned by wildfire in the study area is less than 30 acres; because it is small in scope, the chance of wildfire or suppression in an average year having more than a negligible or minor adverse impact is low. Impacts may be short- or long-term depending on the intensity of the fire or location and extent of suppression activities.

Mechanical Treatments

Mechanical thinning activities such as mowing are not expected to have any adverse impacts on the special status species on Table 21. This is because mowing would be done in the fall after plants have flowered and gone to seed, and rare plants populations would be excluded from treatment areas. Areas are surveyed each year before they are treated to determine whether any special status plants exist on site.

Fire Information/Education

No impact to any plant special status species is expected from the distribution of fire information or education.

Fire Cache/Park Headquarters Relocation, and Construction

Because the area where the fire cache is planned would be surveyed prior to construction, impacts to protected plant species would be minimized. It is possible that individuals would be affected, but the extent of the effect would be minor.

Fire Effects and Fuel Management Research

No effects to any special status plant species from fuel management research under Alternative A are expected.

Federally Protected Wildlife

Northern Spotted Owl (Strix occidentalis caurina) - Threatened
The northern spotted owl (*Strix occidentalis caurina*) was federally listed as threatened in 1990 (USFWS, 1990). Most nesting and roosting sites occur in older, decadent stands of conifer and hardwood trees with large overstory trees, and about 35,000 acres of potential habitat exists in the study area. A recent census estimated a population of approximately 49 owl activity centers (Chow, 1997, Fehring et al., 2001, NPS, unpubl. data). Data on the number of activity centers collected since 1998 appears to indicate a stable population.

While the acreage in the study area is not designated critical habitat for the spotted owl, this is only because the species is already considered protected by virtue of the lands designation as National Park status. In addition to protection offered by NPS policies, the Seashore is implementing the following mitigation measures to minimize any adverse impact from prescribed or wildland fire, or from mechanical treatment.

Mitigation Measures Routinely Used for Activities in Spotted Owl Habitat

- annually identify and map areas where spotted owls are nesting,
- protect occupied and previously used nest sites from unplanned ignitions,
- do not conduct prescribed burns within 400 meters of an occupied or previously used nest site,
- do not conduct mechanical treatments with mechanized equipment within 400 meters of an occupied or previously used nest site between February 1 and July 31 (breeding season), and
- conduct post-treatment monitoring to ascertain any impacts.

Analysis

Under this Alternative, potential effects on northern spotted owls are extremely limited because only two of the FMUs to be treated - Highway One and Bolinas Ridge - are considered habitat.

Prescribed Fire

Under a natural fire regime, spotted owl habitat in the project area was subject to periodic, low-intensity fires. However, fire in the study area has been suppressed for 150 years, and high fuel loadings make large, stand-replacing fires possible. These hot fires can result in type conversions and the loss of spotted owl forest habitat for many years.

Prescribed fire can be an effective tool in protecting and improving spotted owl habitat in the park by helping to reduce unnatural accumulations of fuels and ladder fuels. Spotted owls can coexist with extensive fires of varying intensities within their habitats (Weatherspoon et al., 1992). Because of the existing high level of fuel loading in many areas of the park, even fires that are burning within prescription are likely to burn small areas at intensities high enough to have an adverse effect on some spotted owls by reducing prey items. This is no more than a negligible or minor, short-term, adverse impact, however, especially compared to the increased risk and relatively serious impacts of wildland fire under a regime of fire suppression.

In the old growth stands favored by spotted owls, the dense canopies maintain a higher relative humidity, which reduces heating and drying of surface fuels, thus reducing flammability. Adverse effects from wildland fire would be minimized if fuel loads were reduced in and near spotted owl nesting and roosting areas. This could be done by application of spring prescribed fires that would disrupt fuel continuity and reduce the potential for stand-replacing fires (Weatherspoon et al., 1992).

Adverse impacts on spotted owl territories that are identified prior to ignition of a prescribed fire would be minimized through preparatory burns and mechanical fuel reduction in nesting and roosting habitat to control fire intensity in these areas. In addition, no treatment would occur within 400 meters of a nesting or known roosting site to mitigate any potential impacts. Prescribed fire planning also takes into account other important habitat components, such as down, woody debris that provide habitat for dusky-footed woodrats, which are an important prey species for northern spotted owls in the project area. Fires of an intensity that would reduce the amount of woody debris, or would otherwise adversely affect woodrat habitat or nests would have an indirect minor short-term adverse effect on spotted owls.

Currently, no program elements exist for the management of prescribed fires for the benefit of spotted owls. The use of prescribed fire under Alternative A, would, nonetheless, have a beneficial, long-term, and minor impact on California spotted owls, primarily through reduction in the threat of catastrophic fire in some areas.

Unplanned Ignitions, Wildfire, and Suppression

As noted above, high fuel loadings make hot fires or hot spots within lower intensity prescribed burns more likely. These hot fires can have adverse impacts on habitat by reducing canopy closure or destroying owl prey or their habitat. However, given that the average annual acreage burned from wildfires at the park is quite low, any more than minor adverse impacts from average annual wildland fires are unlikely.

Mechanical Treatments

Under Alternative A, hand thinning or mechanical treatments in the vicinity of development and roads such as on Bolinas Ridge and Highway One FMUs could have an adverse effect on spotted owls through a reduction in canopy closure. This is especially true where developed areas interface with dense forest that provides roosting and nesting habitat. Under Alternative A, cutting large trees would be limited because techniques would be confined to hand thinning and then piling and burning. In some areas, clearing understory vegetation could, in fact, improve foraging conditions for spotted owls and habitat for woodrats.

Chipping is conducted occasionally in this alternative. Chipping involves cutting material and then distributing it over a site where air quality, visitor use, or other management concerns prohibit burning. The equipment used to chip material is extremely loud and, if operated nearby, may disturb spotted owls. Because only a maximum of 500 acres would be treated with mechanical equipment and because only two of the FMUs proposed for mechanical treatment include spotted owl habitat, the impact would be a minor, short-term, adverse one on the owl population in the park.

Fire Information/Education

No impact to spotted owls from the distribution of fire information or education is expected.

Fire Cache/Park Headquarters Relocation, and Construction

The fire cache would not be located in the vicinity of spotted owl activity centers or potential habitat, so no impact is expected.

Fire Effects and Fuel Management Research

No effects to spotted owls from fuel management research under Alternative A are expected.

Red-legged Frog (Rana aurora draytonii) – Threatened
The study area supports one of the largest known populations of California red-legged frogs in the state. A comprehensive survey of aquatic habitat in the study area has located numerous sites in riparian areas, wet swales, seasonal springs, and stock ponds on ranch lands. The survey is ongoing, and is expected to locate many more frog habitats in the Seashore and GGNRA.

PRNS, GGNRA, and adjoining areas of Marin County comprise one of the 57 core areas for focused recovery of red-legged frogs established in the Final Recovery Plan for the species (USFWS, 2002). Much of the project area falls within the recently established criteria for red-legged frog critical habitat (USFWS, 2002). For example, the central peninsula contains numerous stock ponds which retain water at least 20 inches deep well into the summer. Pond habitat and perennial creeks are also clustered, particularly at the Point. These concentrated aquatic habitats and the fact that ground between them is suitable for overland travel by frogs has created an interconnected and critical habitat for this species in the study area. A second

interconnected habitat area extends along the Olema Valley, where the perennial segment of Olema Creek links scattered off-stream aquatic habitats from the vicinity of Point Reyes Station south approximately 13.5 km. Olema Creek runs through the Wilderness South and Highway One FMUs.

Red-legged frogs have also been found on Bolinas Mesa and at several ponds on top of Bolinas Ridge. Since frogs could be present in unsurveyed locations on Inverness Ridge, and could travel along seasonally wet riparian corridors over the ridge, all the red-legged frog sighting locations have been linked into one metapopulation.

Based on survey data, the most important riparian areas for red-legged frogs in the study area are those with a relatively low gradient that have late season water flow or water retention in pools. On Point Reyes itself, such creeks support relatively few of the documented occurrences of the frogs, but they may serve as connector and refuge habitats. The most important of these are Kehoe Creek and Abbott's Lagoon Creek on the north end of the peninsula, and Schooner Creek, which drains into Drakes Estero.

Analysis

The types of impacts fire management activities could have on red-legged frog aquatic habitats are summarized in Table 53, which is based on the Draft Recovery Plan.

Table 53. Potential Impacts on Red-legged Frog Aquatic Habitats from Fire Management Activities

Impact	Potential Effect on CRLF Habitat
Emergent vegetation removed.	Emergent vegetation necessary for amplexus and anchoring egg masses. Excessive levels may reduce sunlight needed for growth of algae, which is chief larvae food.
Shading vegetation removed (emergent and bank side)	Chiefly harmful to adults, for whom shaded refugia may be critical in drier inland areas during the summer.
Insect habitat vegetation removal	Harmful to adults and juveniles that mainly feed on invertebrates for which bank side vegetation is prime habitat.
Excess water drawdown in ponds	Leave egg masses stranded on vegetation
Change hydrological regime by accelerating runoff	Pools may dry before metamorphosis completed

Nearly all of these potentially adverse impacts would result from wildland fire suppression activities or from a wildfire itself. This is because all prescribed burn plans and plans for mechanical treatment in a given year are reviewed and any important riparian areas or other habitat for red-legged frogs avoided. All fire management actions would adhere to a setback from breeding and non-breeding habitat for red-legged frogs

Prescribed Fire

The species appears to be thriving under the current PRNS management, including fire management actions that have been conducted over the past several years and will be continued under this alternative. Prescribed fire, because it is used to restore the natural vegetation structure in park habitats and reduce the risk of catastrophic fire, would have long-term benefits to red-legged frogs and their habitat. These benefits, however, would be limited by the relatively small area (500 acres) that would be burned annually under Alternative A in just four FMUs - Estero, Limantour, Highway One, and Bolinas Ridge.

High levels of fuel loading in some areas may cause prescribed fires to burn at higher than natural intensities, even when fire prescriptions were designed to minimize high-intensity fires. Hotter fires, or fires that may more readily burn unintended areas, could burn riparian habitat and have the effects described in Table 53 above. Higher intensity burns could also result in increased sedimentation in frog habitat. However, the extent of these types of impacts under the prescribed burn program proposed in this alternative would be quite small, or perhaps even largely non-existent. Adverse impacts to frogs would therefore be short-term and negligible because of the small amount acreage burned in each FMUs per year.

Unplanned Ignitions, Wildfire, and Suppression

Because unplanned ignitions may burn in frog habitat, some of the types of impacts identified in Table 53 above could result. Suppression activities - water drops, line construction, retardant drops - could also inadvertently have adverse effects on red-legged frogs, but because of the small acres (30 acres) of wildfire each year, the effects are expected to be short-term and negligible.

Mechanical Treatment

Mechanical treatment such as hand thinning, line construction, and pile burning could disturb frogs or alter their habitat. Frogs may shelter in piles and be killed when they are burned. However, the impact to the park's frog population would be no more than negligible because breeding areas and adjacent non-breeding areas would be identified and avoided before any mechanical treatment is taken.

Reduction in fuel loading by hand thinning or mechanical treatment would have a beneficial effect on red-legged frogs by reducing fuel loads and the threat of catastrophic fire. This treatment, however, would be used in very small areas of potential red-legged frog habitat near buildings for defensive space, otherwise all breeding habitat of red-legged frogs would not be treated. Mechanical treatments by inadvertently killing a red-legged frog could be adverse, but would be short-term, and negligible.

Central California Coast Coho Salmon (Oncorhynchus kisutch) – Threatened and Central California Steelhead (Oncorhynchus mykiss) - Threatened

Central California coast coho salmon and Central California steelhead (hereafter referred to as coho and steelhead) occur in several creeks on the Point Reyes peninsula and in the Lagunitas Creek watershed that drains portions of PRNS and GGNRA. The Bolinas Ridge FMU is located within the Lagunitas Creek, Olema Creek, and Pine Gulch Creek watersheds. The Highway One FMU is located within the Olema, Pine Gulch, and Bolinas Drainage watersheds. The Estero FMU is located within the Drakes Estero watershed and the Limantour Road FMU includes the Drakes Estero, Drakes Bay, and Tomales Bay Watersheds (see Figure 16). Lagunitas Creek watershed is part of the Highway One, Bolinas Ridge, and Wilderness South FMUs. Designated critical habitat for coho in PRNS includes all accessible estuarine and stream areas in the coastal watersheds of Marin County except areas above longstanding, naturally impassable barriers or above Peters Dam on the mainstem of Lagunitas Creek and Seeger Dam on Nicasio Creek (NMFS, 2000). Although critical habitat has not been established for central California steelhead, it is likely to be the same as that for coho in Marin County.

For most drainages presence/absence salmonid surveys have been conducted, while in watersheds supporting coho salmon, abundance data on both species is available. The variable life cycle of steelhead makes population analysis more difficult, but also makes them more resilient to adverse environmental conditions. In general, if the habitat requirements for coho were met, steelhead habitat requirements would also be met.

Tomales Bay Watershed

The Tomales Bay watershed includes all of the small watersheds draining from Inverness Ridge and Bolinas Ridge directly to the Bay. The largest of these watersheds, Bear Valley Creek, is included within the Limantour Road FMU. In 1999, the CSRP conducted a smolt trap survey of Bear Valley Creek confirming the presence of steelhead trout.

Under Alternative A, the Limantour Road FMU would be subject to mechanical treatment and prescribed fire. This FMU represents 3% of the total watershed area (see Table 41).

Lagunitas Creek Watershed

Lagunitas Creek has long supported populations of coho salmon and steelhead trout. Recent monitoring efforts within Lagunitas Creek have identified the presence of Chinook salmon for the past four years (MMWD, 2003) with less frequent occurrences of chum and even pink salmon. Lagunitas Creek, and its tributaries, including Olema Creek, Devil's Gulch, and San Geronimo Creek support 10% of the remaining wild coho population within the central California coast ESU (Brown et al., 1994, NOAA Fisheries, 1996).

Reliable quantitative survey data for coho salmon dates from 1948, when the California Department of Fish and Game (CDFG) began annual surveys of coho numbers and spawning activity on Devil's Gulch, a tributary of Lagunitas Creek. Despite the potentially tenuous nature of spawning survey data and inconsistencies in data collection, review of historical spawner abundance data supports anecdotal evidence of declining numbers of coho over the last 50 years.

Devil's Gulch, the only drainage for which long-term data are available, has experienced a sharp decline in numbers (specifically of the PLD Index, in which the highest count of living fish found in a single survey is added to the cumulative number of dead fish counted up to that time) since 1948. More recently, data for both the PL Index and the number of redds (fish "nests" dug in gravel) over the entire Lagunitas watershed indicate an increase. Total numbers of spawning coho using the drainage are suggested by PLD Index value high counts of 525 fish in 1996/97 (see Table 27).

Under Alternative A, the Bolinas Ridge FMU would be subject to prescribed fire. This FMU represents 3% of the total watershed area (see Table 41).

Like Lagunitas Creek, Olema and its tributaries support both coho salmon and steelhead trout. The perennial section of Olema Creek has been systematically surveyed for live adult coho, carcasses, and redds since the winter of 1994/95 (Table 30). Cumulative monitoring results within the Olema Creek watershed, including the mainstem and John West Fork (see Table 31), show considerable variability from year to year and within the cohort years. As in other creeks in the Lagunitas drainage, Olema Creek had a high count for coho salmon in the winter of 1996-97, with a PLD Index value of 174 and the lowest count three years later with a PLD index value of 27. This variability encompasses the range observed within the watershed since 1994/95. In recent years, the coho PLD index numbers have shown a rebound with a PLD index value of 161 fish and 134 redds in 2000/01 and 110 fish and 84 redds in 2001/02.

Under Alternative A, the Bolinas Ridge FMU would be subject to prescribed fire while the Highway One FMU would receive both prescribed fire and mechanical treatment within the Olema Creek watershed. These FMUs encompass 20% of the total watershed area (see Table 41).

Drakes Bay Drainages

The Drakes Bay watersheds include all those draining directly to the Bay from Double Point, north and west to Chimney Rock, with the exception of the watersheds within Drakes Estero (described as separate watershed unit). Watersheds south of Drakes Estero support steelhead trout. While no quantitative surveys have been conducted in the watershed, presence/absence surveys have confirmed steelhead trout to the watersheds south of Drakes Estero.

Under Alternative A, the Limantour Road FMU would be subject to mechanical treatment and prescribed fire. This FMU represents 6% of the total watershed area (see Table 41).

Drakes Estero Watershed

Watersheds draining to Drakes Estero including East and North Schooner, Glenbrook, Muddy Hollow, Home Ranch, and Laguna Creeks support steelhead trout.

Under Alternative A, the Estero and Limantour Road FMUs would be subject to mechanical treatment and prescribed fire. These FMUs represent 23% of the total watershed area (see Table 41).

Bolinas Drainages

The Bolinas drainages including Lewis Gulch and Arroyo Hondo support perennial stream flow and steelhead trout.

Under Alternative A, the Bolinas Ridge FMU would be subject to prescribed fire while the Highway One FMU would receive both prescribed fire and mechanical treatment within the Bolinas Drainages. These FMUs represent 10% of the total watershed area (see Table 41).

Pine Gulch Creek

Pine Gulch Creek supports a population of steelhead and it is generally accepted that it supported a native self-sustaining population of coho salmon into the 1970s. Following thirty years without documented coho sightings, recent NPS monitoring activities have detected the presence of three consecutive cohort year classes in Pine Gulch Creek. Beginning in winter 2000-2001, coho salmon spawners have been observed in low numbers (<5 per year) within the watershed. Modified Hankin-Reeves surveys yielded estimates of 589 (± 329) juvenile coho salmon in September 2001 and 1205 (± 337) juvenile coho salmon in September 2002. The 2002 survey results indicate higher abundance and wider distribution of coho than the 2001 survey. In response to juvenile presence in 2001, a smolt trap was operated in the spring of 2002 capturing 249 coho smolts (Ketcham & Brown, 2003). Evaluation of genetic samples indicate that coho salmon captured during summer 2001 in Pine Gulch Creek have a strong genetic affinity to coho in the Redwood Creek watershed, Marin County (Garza personal communication), six miles to the south.

Under Alternative A, the Bolinas Ridge FMU would be subject to prescribed fire while the Highway One FMU would receive both prescribed fire and mechanical treatment within the Pine Gulch Creek watershed. These FMUs represent 23% of the total watershed area (see Table 41).

35% of the Highway One FMU is within the Pine Gulch Creek watershed.

Analysis

Under Alternative A, the treatments proposed could affect coho salmon and steelhead trout because all four FMUs to be treated have one or both species of fish. Highway One FMU has the greatest potential for possible impacts because of its proximity to Olema Creek and Pine Gulch Creek. The FMU surrounds the road corridor and includes more than 8 kilometers of mainstem habitat supporting coho salmon and steelhead trout.

Prescribed Fire

Fire can modify the quantity, quality, and use of salmonid habitat by altering riparian cover, water temperatures, sedimentation rates, nutrient availability food resources, and woody debris in streams. Because the small to medium sized streams that provide habitat to coho salmon and Central California coast steelhead have narrow valley floors, steep hillsides, and abundant

rainfall, they are particularly sensitive to the effects fire can have of removing vegetation and increasing erosion. Riparian zones and fish populations can be influenced by fire and fire management activities occurring upslope as well as along the stream, although a 100 foot buffer between any prescribing burning or mechanical treatment is maintained.

Water temperature is a major factor affecting fish survival, distribution, and production, and can lead to alterations in the timing of critical life history events such as emergence of fry from spawning beds and smolt migration, or to changes in fish species composition in streams. These indirect, longer lasting impacts on water temperature can significantly affect fish populations. Research indicates streamside vegetation can play an important role in maintaining water temperatures. Evidence shows that when streams are protected from fires by a buffer strip of vegetation there is no increase in water temperature during burning (McMahon and deCalesta, 1990). As noted in Alternatives, park scientists would review any given burn plan and determine whether riparian vegetation along streams in the area may need to be retained during a prescribed burn. It is likely this mitigation measure would be added if coho or steelhead are present, preventing more than minor impacts from water temperature changes.

High levels of fuel loading in some areas of the park may create hot spots, or prescribed fires that burn at higher than natural intensities. This would decrease over time as more and more acreage is cumulatively treated, but could cause increased run-off and nutrient loads, even when fire prescriptions are designed to minimize high-intensity fires.

Many studies have assessed the effects of fine sediment on salmonid populations. Direct effects of suspended sediments on fish begin to be observed between 50 and 100 milligrams per liter. (Herbert and Merkens, 1961; Newcombe and MacDonald, 1991; Newcome and Jensen, 1996). Chronic exposures to concentrations greater than 100 milligrams per liter impaired feeding and caused reductions in growth rates, avoidance, and downstream displacement. Adult anadromous fish may avoid concentrations greater than 350 milligrams per liter, impeding upstream migrations (Brannon et al., 1981, Whitman et al., 1982). Stress, as measured by changes in blood chemistry, was reported in fish exposed for short periods to sediment concentrations as low as 50 milligrams per liter (McLeay, et al., 1983). Despite these indications of adverse effects, salmonids thrive in turbid rivers of the northwest, and are able to both live and reproduce in them, even when sediment concentrations are quite high. For example, steelhead were able to spawn in the North Fork of the Toutle River in August 1980, only three months after the eruption of Mount Saint Helens in Washington.

As noted above, PRNS always includes a minimum 100 foot buffer between any prescribed burns and riparian areas. Despite this mitigation measure, prescribed burning could result in increased turbidities in some streams or creeks in the park. Vegetation in the burned areas would return quickly and sediment loss would slow over time. In addition, if upon review of a particular burn plan by park specialists, turbidity increases for coho or steelhead is considered a possible moderate or major adverse impact of prescribed burning, the burn may be cancelled or a series of mitigation measures put in place to bring sediment levels down.

To assure that anadromous salmonid species are protected, Mitigation Measure S-1 would be implemented. This mitigation measure requires that burn plans prepared by the NPS and be

reviewed by a subject matter expert such as a hydrologist, erosion specialist, or fisheries biologist to assure that associated erosion control plans and riparian protection corridors are adequate to protect sensitive habitat and resources, prior to approval for implementation. The subject matter expert would determine whether the erosion control plan and riparian protection corridors are sufficient to prevent long-term moderate or major impacts to salmonid habitat. In other words, the expert would determine whether the proposed erosion control strategy would be sufficient to ensure no greater than minor impacts to salmonid from erosion or impacts to the riparian corridor. If the assessment finds that standard setbacks would be insufficient to avoid a long-term moderate or major effect on the salmonid habitat, wider buffers or staggered burning regimes would be implemented. Some of the strategies used to minimize impacts to soils are to avoid steep slopes, time burns to maximize favorable environmental conditions, and erosion control devices during burns.

Coho salmon and steelhead trout appear to be stable under the current PRNS management, including fire management actions that have been conducted over the past several years and would be continued under Alternative A. Prescribed fire, because it is used to restore the natural vegetation structure of park habitats and reduce the risk of catastrophic fire, would have a long-term benefit by protecting dense riparian habitat, keeping water temperature in appropriate ranges, and controlling sediment loading to the stream for these two species. This benefit would be limited by the relatively small area that would be burned annually (500 acres) under Alternative A.

Unplanned Ignitions, Wildfire, and Suppression

As noted above, fire can modify the quantity, quality, and use of salmonid habitat by altering water temperatures, sedimentation rates, riparian vegetation, nutrient availability, food resources, and woody debris in streams. Also, the small to medium sized streams that provide habitat to coho salmon and Central California coast steelhead in the study area are particularly vulnerable to the effects of fire because they are located in steep confined valleys. Whereas prescribed burning is controllable, and can therefore be planned to avoid burning riparian vegetation, unplanned ignitions cannot. In addition, since unplanned ignitions can start anywhere, wildfires can burn hotter when they start. Suppression activities, including line construction, and drops of water or retardant, could also affect water quality or increase erosion temporarily. However, because wildfires in the study area are quite small on average, these adverse effects on coho or steelhead would be no more than minor and short-term. The effects of a larger wildfire are discussed in cumulative impacts.

Mechanical Treatment

Hand thinning and pile burning actions taken to manage prescribed fire would have no-effect or negligible adverse effect on coho and steelhead trout and would not increase sedimentation. The impact is considered negligible because riparian areas and 100 foot buffer strips would not be treated and would reduce or eliminate any sedimentation increase.

California Freshwater Shrimp (Synacaris pacifica)- Endangered
The California freshwater shrimp is found only in sections of a few coastal streams in Marin, Sonoma, and Napa counties. All are low gradient and low elevation streams with undercut banks, exposed roots, woody debris, or overhanging vegetation. They inhabit stream pools one to three feet deep and away from the main current where they hide among willow, blackberry, or other roots (Serpa, 1991). They feed on detritus, including fish that may die as streams dry to isolated pools in the later summer. Existing populations are threatened by introduced fish; deterioration or loss of habitat resulting from water diversion and impoundment; livestock, dairy, and other agricultural activities and developments; flood control activities; gravel mining; timber harvesting; migration barriers; and water pollution. In the study area, the shrimp is found in a portion of the main stem of Lagunitas Creek where it is generally protected from agricultural activities occurring within the watershed. All of Lagunitas Creek occurring in the park is located in the Bolinas Ridge FMU, which would receive treatment from prescribed burning in all alternatives, and from mechanical treatment in Alternative C. Small numbers of shrimp were collected in 1996 and 1997 near the confluence of Olema and Lagunitas creeks (Fong, 1999).

Analysis

Prescribed Fire

The most important features of the environment inhabited by this species in the park are likely to be the continued presence of a structurally diverse stream environment and slower flowing or pooled water. Each of these is dependent on the presence of intact riparian vegetation. As noted above in the discussion of federally listed fish species and red-legged frogs, prescribed burning is generally not conducted in riparian vegetation. If a particular prescribed fire in the Bolinas Ridge FMU may affect riparian vegetation along Lagunitas Creek, park staff would make use of mitigation measures or other standard practices to ensure no habitat of the California freshwater shrimp is affected either directly or indirectly. In addition, prescribed fire, because it is used to restore the natural vegetation structure of park habitats and reduce the risk and possible extent of catastrophic fire, could offer long-term benefits for shrimp. Because the benefit to shrimp would be localized to sections of the Lagunitas Creek and would cover a small area, they would be negligible. These benefits could be short- or long-term, depending on whether the treated areas return to natural fire intervals quickly or need additional treatment.

Unplanned Ignitions, Wildfire and Suppression

As noted in other sections, although the type of impacts from wildland fire and prescribed burning can be similar, their location and intensity can be quite different. The chance of an unplanned ignition burning riparian vegetation on the Lagunitas Creek is higher than prescribed burning and so impacts from changes in vegetation cover or stream flow characteristics are also higher. However, since so few acres burn from wildfire in the study area in an average year, it is both unlikely that riparian vegetation in the habitat area of the shrimp would be affected, and that the impact would be more than negligible if a fire did burn some of this vegetation. The same is true for suppression activities, which could have adverse effects from increases in erosion from line construction, or changes in water quality from retardant drops. Again, because of the small

size of most wildfires, the expected impact to shrimp habitat would be non-existent or negligible and short-term.

Mechanical Treatment

No mechanical treatment of Bolinas Ridge FMU is planned for this alternative. Therefore, no impact to California freshwater shrimp is anticipated.

Myrtle's Silverspot Butterfly (Speyeria zerene myrtleae) – Endangered
Myrtle's silverspot butterflies inhabit coastal dune, coastal prairie, and coastal scrub habitats in the study area. It is believed to be extinct everywhere except inside and nearby PRNS. Reasons for its extinction include urban and agricultural development, invasive non-native plants, livestock grazing, over collecting, and other human impacts. Also, although the species uses several plants in the area to obtain nectar, it has only been known to use one, western dog violet (*Viola adunca*), to feed its larvae. The patchy nature of this plant in the area may also have contributed to the rarity of silverspot butterflies.

Three populations are known in the area. One is near the Estero de San Antonio, a second is centered on North Beach, but extends from Abbott's Lagoon to South Beach and east to Drakes Estero and Drakes Beach, and the third is on the Tule Elk Reserve. The highest numbers have been found along the dune-scrub interface in the back dune area of the central peninsula on F and G ranches and the AT&T property, and on the bluffs on either side of the Drakes Beach visitor center. All known populations inside the park are located in the Minimum Management Unit of the park, and would not be affected by prescribed fire or mechanical treatment.

Silverspot numbers in the area outside of park lands around the Estero de San Antonio were estimated at 2,000-5,000 individuals in 1991. Other nearby areas with potentially suitable habitat were not surveyed. Together with those found at Point Reyes, estimated numbers for the three known populations of the species total less than 10,000 individuals (USFWS, 1998). Due to the lack of historic data previous to the 1990s, it is not known if the silverspot has declined at Point Reyes. While surveys of the two populations during the period 1993-1997 found that the Tule Elk Reserve population remained stable and the central Point Reyes population declined sharply, such variation is well within that normally found in Speyeria species (USFWS, 1998).

Analysis

While it is difficult to determine the status of Myrtle's silverspot population at PRNS given current information, the species does not appear to be at risk of extinction in the near future (Launer et al., 1992). In addition, the PRNS does not know if the population is stable, increasing, or declining because of lack of historical data.

Cattle grazing has been identified as only one of a number of possible reasons for the species decline, but is also considered valuable in maintaining Myrtle's silverspot habitat. While several areas have been identified where grazing may be adversely affecting the species' habitat at PRNS, overall grazing management has helped maintain a variety of plant cover conditions in Myrtle's silverspot habitats.

Under Alternative A, all of the occurrences of Myrtle's silverspot are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuels treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur within pastures routinely grazed by cattle where fire is unlikely to carry.

Western snowy plover (Charadrius alexandrinus nivosus) – Threatened
Western snowy plovers use the Point Reyes peninsula as both wintering and nesting habitat. Wintering birds occur around Drake's Estero and Abbott's Lagoon, and along Limantour Spit and the Great Beach. Nesting is occurring on the northern portion of Great Beach and along the western edge of Abbott's Lagoon.

Monitoring of nesting snowy plovers in 1986-1989 and 1995-2002 indicated a decline in the number of nesting birds through 1996, followed by a gradual rebound. This rebound is at least in part due to a program initiated in 1996 to increase nesting success. The program includes the use of signs, closures to dogs and/or human visitors, exclosures over nests and the use of docents to monitor visitor use and increase visitor education. The current nest protection program has raised nest success rates to levels similar to those at other coastal California locations.

Analysis

All of the occurrences of western snowy plovers are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuel treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the plovers occur in beach areas where fire is unlikely to carry.

Ravens are the primary predator on eggs and small chicks of plovers. Ravens and crows may be attracted to fires because potential prey are exposed and concentrated around fires. Fires may indirectly affect plovers if ravens concentrate in burned areas adjacent to plover nesting habitat and if raven populations are enhanced by a boost in prey available during a fire.

Additional Wildlife Species of Management Concern

This section analyzes impacts to wildlife that are not federally listed, but may be affected by fire management activities. Because Point Reyes Mountain Beaver is most likely to experience impacts, it is treated separately.

Point Reyes Mountain Beaver (Aplondontia rufa phaea)
The Point Reyes mountain beaver, a muskrat-sized rodent found only in scrub habitat in western Marin and almost entirely in Point Reyes National Seashore, is listed as a Species of Concern by the US Fish and Wildlife Service and the California Department of Fish and Game. Two small, geographically isolated populations of mountain beaver live along the California coast, both of which are distinct subspecies. The Point Arena mountain beaver (*A. r. phaea*) is federally listed as Endangered. Its entire range encompasses approximately 60 km^2. Mountain beaver may be

adversely affected by actions described in the Fire Management Plan alternatives, but most particularly by large-scale unplanned ignitions.

Analysis

Prescribed Fire

The mountain beaver was severely affected by the 1995 Vision wildfire in Point Reyes, presumably through direct destruction and dehydration, as roots and vegetation from which is obtains water was destroyed on over 12,000 acres. This species is known to require up to two cups of water per day to survive. However, prescribed fires in this alternative and all alternatives in this EIS would not burn large areas of brush, or burn with the kind of high intensity characteristic of the Vision wildfire. Mountain beaver would be able to outrun or avoid a prescribed burn over most of its habitat, and would be able to survive on neighboring plants until its habitat is revegetated. Revegetation would occur quickly, as prescribed burns are timed to fall before the rainy season in most cases. Ultimately, the kind of succulent plant material mountain beavers require would be more abundant as a result of controlled burning over the up to 500 acres allowable under Alternative A. Mountain beaver are known to occur in Estero and Limantour FMUs, slated for prescribed burning in this alternative, and so a negligible to minor long-term benefit from using prescribed fire to reduce the risk and extent of a large-scale wildfire is likely.

Unplanned Ignitions, Wildfire and Suppression

Studies conducted before and following the 1995 Vision Fire in Point Reyes revealed that Point Reyes mountain beaver suffered high mortality. Pre-fire estimates indicated about 5,000 individuals in the area ultimately burned. Following the fire, only 19 live mountain beavers, or less than 1% of the pre-fire population, were located over this same area (Fellers et al., 2003). Major vegetation changes occurred in parts of the beavers' habitat, including a reduction in coastal scrub and coyote brush. Monitoring in the years following the fire indicate that recovery of the populations has been slow (Fellers, 2003).

Fellers (2003) recommended that fires in the vicinity Point Reyes mountain beaver not be allowed to burn substantial portions of areas occupied by mountain beaver. Periodic small fires, such as prescribed burns or wildfires in an average year at the park, would allow for normal changes in mountain beaver habitat by mimicking what was probably the natural fire regime with which these animals evolved.

The following mitigation measures would be implemented:

- identify and map areas known to support Point Reyes mountain beaver and areas that have habitat suitable for supporting Point Reyes mountain beaver,
- protect known and potential habitat from unplanned ignitions,
- establish buffer areas 30 feet wide around known habitat areas, and
- conduct small burns (less than 100 acres) of mountain beaver habitat each year.

Implementing these mitigation measures would keep impacts of average wildfires in the study area to no more than minor and short-term.

Mechanical Treatment

The presence of humans thinning brush or conducting other activities such as chipping could disturb mountain beavers, but the impacts would be minor and temporary. Mechanical treatment would help to remove fuels and reduce the risk of another catastrophic wildfire in the park. Because mechanical treatment would be limited in scope in this alternative, this beneficial impact would also be no more than a minor one, although over several years the reduction in risk could be a larger and more permanent one.

Other Special Status Wildlife

Analysis

Table 33 in Affected Environment lists several animal species in the project area that are listed as federal Species of Concern. Species of Concern are those for which USFWS is collecting additional information to determine if they warrant consideration for future listing. The animal Species of Concern lists 9 mammals, 23 birds, 3 reptiles, 2 amphibians, 3 fish, and 10 invertebrates. The table also shows which species are potentially subject to adverse effects.

Prescribed Fire

The effects of fire on the animal species listed in Table 33 are not fully known. However, the park's mean surface fire intervals of 7 to 13 years (Brown et al., 1999) indicate fire is an integral part of the natural ecosystem at Point Reyes. Fire research has demonstrated that fire plays a critical role in the management of many species of concern with regular burn intervals. For example, fire helps maintain open areas, creates a diversity of habitats, can create food sources, and in some cases, removes non-native competitors. Even though individuals of some Species of Concern may be killed by prescribed fire, the removal of competitors has a long-term beneficial effect as fire dependent native species will return, while the non-native competitors often will not (National Biological Service, 1995).

Regarding effects on mammal species of concern, Ream (1981) summarized information in 237 references about effects of fire on fauna. She concluded that populations of ground squirrels, pocket gophers, and deer mice generally increase after stand-replacing fire. On the other hand, Wirtz (1977) found that populations of brush mouse, western harvest mouse, and woodrat species decrease or disappeared in burned chaparral and grasslands. At Point Reyes, the mammals of concern are primarily bat species. Based on the limited number of acres to be burned and the ability o f bats to leave an area, minor short-term impacts could be both beneficial (creates food sources) and adverse (some mortality may occur in roosting sites).

The species of concern Table 33 includes 23 species with only eight species that have the potential to be affected. The olive-side flycatcher and Pacific-slope flycatcher could be beneficially affected because studies have shown flycatchers (Wirtz, 1977) increased the first

year after a burn. White-tailed kites could be beneficially affected because raptors in general are unaffected or respond favorably to burned habitat (Smith, 2000). It is not known how other species of birds Allen hummingbird, short-eared owl, tricolored blackbird will respond to fire; however, because of the limited number of acres burned each year, the effects on populations of these species would be minor.

Amphibians and reptiles Species on Concern on the USFWS list should not subject to adverse effect because most do not occur in the project area. Only one species, the northwest pond turtle, is known to occur and it major habitat - ponds - would not be subjected to burn treatments.

No fish Species of Concern would be impacted by prescribed fire.

There are ten invertebrate Species of Concern. The potential to impact these species is primarily unknown. However, soil protects most soil macrofauna and pupae of many insects from fire. In addition, a study by Evans (1971) indicates 40 species of arthropods are attracted to fire and many uses burned trees for breeding and food.

To sum, based on the above and because prescribed fire would be limited in scope and would not involve a large component of the habitat of any population of animal Species of Concern, impacts to animal Species of Concern would be limited. This means both the potential for adverse or beneficial impacts would be no more than minor. Adverse impacts would be short-term for the most part, but beneficial impacts could be long-term.

Unplanned Ignitions, Wildfire, and Suppression

The average acreage burned by wildfire in the study area is less than 30 acres; because it is small in scope, the chance of wildfire or suppression in an average year having more than a negligible or minor adverse impact to other special status wildlife is low. Impacts may be short- or long-term depending on the intensity of the fire or location and extent of suppression activities.

Mechanical Treatments

Mechanical thinning activities such as mowing are not expected to have any long-term adverse impacts on the other special status species on Table 33.

Regarding effects on mammal Species of Concern, at Point Reyes, the mammals of concern are primarily bat species. Based on the limited number of acres to be mechanically treated and the ability of bats to leave an area, minor short-term impacts could be both beneficial (creates food sources) or diverse (some food sources many be lost).

The bird Species of Concern table includes 22 species with only eight species that have the potential to be affected. However, because of the limited number of acres to be mechanically treated each year and mowing would be done after the nesting season, the effects on populations of these species would be short-term and minor. There may be long-term beneficial effects because of the maintenance and creation of a mosaic of habitats.

Amphibians and reptiles species on concern on the USFWS list should not subject to adverse effect because most do not occur in the project area. Only one species, the northwest pond turtle, is known to occur and it major habitat - ponds - would not be subjected to mechanical treatments.

No fish Species of Concern would be impacted by mechanical treatments.

There are ten invertebrate Species of Concern. The potential to impact these species is primarily unknown. However, because soil disturbance would be minimal and the total number of acres to be treated is small, impacts would be short-term and negligible to minor.

To sum, based on the above and because mechanical treatments would be limited in scope (compared to total park acres) and would not involve a large component of the habitat of any population of animal Species of Concern, impacts to animal Species of Concern would be limited. This means both the potential for adverse or beneficial impacts would be no more than minor. Adverse impacts would be short-term for the most part, but beneficial impacts could be long-term.

Effects of Fire Information/Education on Special Status Wildlife

Impacts associated with fire information and education would largely be indirect and beneficial, although they would be highly dependent on the nature of the fire management action on special status species. Pre-planned events such as prescribed fires and mechanical treatment provide the opportunity to demonstrate the effectiveness of natural resource management to local communities and the interested public. During unplanned events, such as wildfires, time for effective communication is often more limited and can be more controversial since resources are often damaged. However, education does not usually have a direct effect - positive or negative - on impacts to special status species. In some cases, education can be used to enforce a closure of an area to ensure a special status species is protected or to ensure voluntary compliance for actions that would help ensure the survival of the special status species.

Effects of Fire Cache/Park Headquarters Relocation and Construction on Special Status Wildlife

No adverse or beneficial indirect effects are anticipated with the construction of the new fire cache. The building site is a former trailer pad that was recently removed in the main developed area of the park at Bear Valley and has already been heavily impacted. The area has been surveyed and has no special status species in the construction footprint.

Fire Effects and Fuel Management Research

No adverse or beneficial direct effects are anticipated on wildlife from the implementation of Alternative A research projects. There are indirect beneficial effects for conducting research that would help identify future management prescriptions for special status species protection.

Cumulative Impacts of Alternative A to special status plant and animal species

This section describes impacts from sources other than the fire management plan that have or are adversely affecting the special status species analyzed above, or that may adversely affect them over the life of this plan. The known sources of impact are human development and human activities both inside and outside the park, construction activities listed in Appendix C, and a large-scale wildfire in the region.

Perhaps the largest threat to these species from park activities is the risk of a large-scale fire similar to the 1995 Vision Fire. The effects of such a fire would be intensified by the fuel buildup in the park associated with a policy of fire suppression over the last 150 years. As did the Vision Fire, another very large and hot fire could create a multitude of habitat changes and serious impacts for park wildlife, including extensive forest gaps, discontinuous habitat, and greater consumption of large woody debris than what would be expected under natural fire conditions. High-severity fires in Point Reyes are characterized by extensive burned areas that may be continuous from ridgeline to slope bottom and include riparian areas, eliminating habitat for several of the species identified above, such as red-legged frogs, coho, steelhead and California freshwater shrimp. In addition, there would be a type conversion of habitat in some areas - forest to brush/grassland and some long-term loss of forest habitat. This change in habitat could have short-term major adverse impacts or long-term moderate impacts to species status species in the burned area. For example, the Vision Fire had a major adverse effect on mountain beaver, and the population is only slowing recovering (Fellers, 2003).

A secondary widespread and serious consequence of catastrophic fire is the increase in erosion and turbidity that follows the loss of vegetation. Sediment loads following a wildland fire similar to the Vision Fire would be expected to be at least twice the normal load under natural conditions (Ketcham, 2003). The sediment loads and lack of riparian vegetation would have adverse, moderate, long-term impacts (more than two years) to special status fish and aquatic species such as coho salmon, steelhead trout, and red-legged frogs. However, vegetation would return in the long run, as it has following the 12,000+ acre Vision Fire, and rates of erosion would return to rates within the natural rate of variability, preventing long-term impairment of park resources.

Species specific cumulative impacts from both large-scale fire and other relevant sources are described below:

Northern Spotted Owl. Cumulative impacts to spotted owls come from development, visitor use, habitat changes, and can come from large-scale fire.

Visitor use in the park is expected to increase along with the projected human population increase in the San Francisco Bay Area. With increased visitor use of the park, the potential for human disturbance of owls along trails may increase. To reduce visitor impacts to owls, the park does not publish the location of owl activity centers and distributes a flyer on how to behave around owls.

Oaks in Marin and Sonoma counties have been dying suddenly over the past few years as a result of a fungus. The die-off, called Sudden Oak Death (SOD), has spread throughout Marin county and is currently in some owl habitat in the park. The death of the oaks results in local changes in percent cover and in food availability of the dusky footed woodrat, the primary prey of owls, at PRNS (Chow and Allen, 1996). Widespread habitat conversion is not expected from SOD in the study area; however, park biologists are monitoring the distribution of the die-off. Additionally, UC Berkeley (P. Gong, Professor, ESPM, UCB, pers. com.) is mapping the spread of the disease throughout Marin County.

An ongoing threat to spotted owls is development, which removes habitat and creates smaller blocks of forest, or forest that is discontinuous. As noted in Affected Environment, smaller isolated tracts of forest that would otherwise be suitable do not meet the needs of spotted owls, which require large contiguous blocks. Of the four categories of land described below, private land without conservation easements or other protection is most vulnerable to development.

Public land protected from development in perpetuity. These include the 2,700 acre Samuel P. Taylor State Park and the 21,250 acres held as watershed and public recreation areas by the Marin Municipal Water District (MMWD). These lands border the Northern District of GGNRA along Nicasio and Bolinas Ridges and provide unbroken habitat connections to an extensive area of central Marin County. The Tomales Bay State Park provides unbroken habitat along the east side of the bay contiguous to GGNRA lands at and near the mouth of Lagunitas Creek.

Privately owned conservation land. Land that has been purchased by non-profit groups for conservation purposes offer long-term habitat protection only slightly less secure than that of publicly held land. The Audubon Canyon Ranch (ACR) includes an inholding on Bolinas Lagoon that connects GGNRA lands adjoining it. Other ACR holdings on Tomales Bay protect undeveloped bay frontage adjoining State Park lands. A second non-profit group, the Vedanta Society, holds a 2,143 acre parcel in the Olema Valley bounded by PRNS and GGNRA lands. Acquisition of this land by the NPS has not been pursued because the Vedanta Society conducts only low impact activities on the property. Acquisition could still take place if management of the land was considered inconsistent with NPS policies.

Private land. In 1971, county supervisors enacted A-60 zoning (one house per 60 acres) for much of western Marin, significantly limiting the development potential of agricultural properties. Such zoning covers extensive areas of private land adjoining public park and watersheds, including San Geronimo Valley, Nicasio Valley, and the northwestern portion of the county. Since that time, zoning for the West Marin Planning Area has been elaborated to include a variety of zoning densities in areas adjacent to established towns, with minimum lot sizes ranging from one unit per acre to one unit per 60 acres.

While these policies provide substantial protection for owl habitats, they could be overturned by the county Board of Supervisors, and so cannot be regarded as permanent protection. At this time, support for low-growth, low-density development policies in Marin County is high and it seems highly unlikely that this will change in the future.

Private land with conservation agreements. Agricultural land in west Marin has been and continues to be at risk of being broken up into the large residential lots permitted by county zoning. To prevent this, a private non-profit land trust, the Marin Agricultural Land Trust (MALT), has been acquiring development rights to agricultural land since 1980. At present, this group holds the rights for over 30,000 acres on 43 ranches in western Marin County. Like other conservation lands held by non-profit groups, the security of protection of these lands depends on the future financial condition of the non-profit, which in the case of MALT appears to be secure.

The impact of a large wildfire on spotted owls would be habitat destruction. As noted in Affected Environment, this species requires greater than 60% total canopy cover for nesting/roosting with large overstory trees, large amounts of down woody debris and the presence of trees with defects or signs of decadence in the stand. This old growth type forest in the park may have the high fuel loading and ladder fuels to feed a hot stand-replacing fire, which would eliminate the habitat for many years. In a large wildfire, such as the Vision Fire, the chances of directly destroying nests or habitat could be quite high. Suppression activities such as water and retardant drops would have an adverse effect on spotted owls if they occurred over nesting habitat and, especially, nests. Such events are less likely than direct destruction of nests or habitat to occur, and impacts would be mitigated if nest sites and probable nesting habitat could be avoided. Helispots and spike camps would potentially have an adverse effect on spotted owls if they were located close to nesting or roosting areas and the level of disturbance were high. Hand-line for suppression, if constructed through a spotted owl nesting or roosting area, would potentially cause adverse effects from disturbance and habitat alteration, especially if trees were felled. Snags are often used by spotted owls as nest sites. As such, snagging operations to protect human safety and the integrity of fire lines would potentially have an adverse effect on spotted owls.

Red-legged Frogs. As described above, lands outside of PRNS and GGNRA offer substantial protection for wildlife through conservation easements, zoning, and low-impact land use practices. Extensive areas adjoining the study area preserve continuous habitat and much of that land is occupied by the red-legged frog. These parcels include nearly 25,000 acres of public land, thousand of acres of conservation land privately held by non-profit groups, and over 30,000 acres of private land with conservation easements preventing development. In addition, much of western Marin is zoned at a very low density, particularly where it adjoins watersheds where red-legged frog habitat exists.

Additional impacts to frogs may come from actions listed in Appendix C, including some restoration projects such as of the Giacomini wetlands or of fisheries in streams where frogs are known to occur. Impacts would be avoided, minimized, or mitigated however, and all project sites would be reviewed prior to implementation with the park GIS database. If there was potential for a take, the park would have staff specialists survey the site and provide recommendations for avoidance or mitigation. In the long-term, these fisheries restoration projects would benefit frogs by enhancing natural processes, including reduction of erosion and stream temperature and enhanced water quality.

Human activities may have had both direct and indirect effects on red-legged frogs. Development has removed habitat, and logging or other activities may have adversely affected geomorphological stability, erosion rates or river channels. For example, historic logging of parts of Inverness Ridge, channel alterations in the lower 2.8 km of Olema Creek, and the effects of highway culverting have removed suitable habitat along Olema Creek and its tributaries may have been. Areas of downcutting, bank cutting, and sedimentation are present along the mainstem and its tributaries, resulting in a probable reduction in numbers of backwaters and pools.

Ranching may also have adversely affected frog habitat, although since coming under NPS ownership and oversight, ranching practices on PRNS ranchland have been modified in ways that have likely benefited California red-legged frogs. Especially effective have been the reductions of cattle numbers on excessively grazed ranchlands and exclusion of cattle from a number of wetland sites. The species appears to be thriving under the current PRNS management of grazing lands, although cattle may be having adverse impacts in some locations. Current information supports the conclusion that grazing may both benefit and harm red-legged frogs, and that more research on optimal habitat conditions for the species is needed. Because cessation of grazing may be more deleterious to the species than its continuation, however, ranching permits would be renewed. Efforts to identify and protect potentially vulnerable habitats and to develop research that would improve knowledge of the best habitat conditions for the species, as described in the Draft Recovery Plan (USFWS, 2000), would be undertaken.

As noted above, fire can adversely affect frogs by removing riparian vegetation, and through the increase in sedimentation accompanying vegetation removal. Both of these effects would be more likely and more severe in a large-scale wildland fire than under a regime of prescribed burning or average wildland fire conditions.

PRNS is currently conducting a wetland mapping and assessment project within the public lands of the Tomales Bay watershed, including Olema Creek, Lagunitas Creek, and Tomales Bay FMP watersheds. The purpose of this project is to map wetlands and to conduct functional assessments of the wetland features within the watershed. Wetlands were previously documented using National Wetlands Inventory (NWI) procedures, which produced incomplete wetland mapping for PRNS and some areas of GGNRA. Only larger, more visible wetland types were mapped, while many of the variety of wetland types found at Point Reyes were missed. When completed, this work would provide data needed for future wetland protection, restoration, and planning. Such protection would likely benefit red-legged frogs and water quality within the project area.

Dating back to the late 1800s, West Marin County was a popular destination for salmon fishing. Records of salmon hatchery releases to Lagunitas Creek and even Bear Valley Creek occurred even in the 1890s. Lagunitas Creek (then known as Papermill Creek) still holds the distinction as having produced the state record, 22 pound, coho salmon (caught by Milton T. Hain, January 3, 1959). Interviews with long time residents and fisheries managers suggest that coho and steelhead in the project area have been declining since the turn of the century, with significant declines occurring as late as the mid-1950's. Most historic information on salmonid numbers is anecdotal, while quantified data are lacking. Accounts by local residents of "excellent trout

fishing" along Lagunitas and Olema creeks may refer to young steelhead, which are indistinguishable from rainbow trout during the three year period they typically spend in fresh water. Similarly, early accounts of "salmon runs" may refer to both coho and steelhead, which may not have been distinguished by fishermen. Such anecdotal information suggests that salmonids were abundant in the Lagunitas/Olema Creek drainage before extensive alteration by dam-construction, logging, and channelization. On its 1996 federal listing, the Lagunitas watershed, including Olema Creek, was documented to support 10% of the Central California Coast coho population (Brown et al., 1994; NOAA Fisheries, 1996).

The mouth of Lagunitas Creek and adjacent floodplain supports activities associated with the Waldo Giacomini dairy. This 563-acre property, once tidal wetlands, was diked and drained in the early 1940s to create pastures. For many years, a gravel dam was constructed annually just below the confluence of Lagunitas and Olema creeks for irrigation and stock watering. The dam created an abrupt transition from fresh to saline water for smolts and spawning adults, eliminating the transition zone found in an unimpaired estuarine system. The transition zone allows smolting fish time to adjust to saline conditions and provides productive feeding zones where both freshwater and saltwater invertebrates are available (SWRCB, 1995).

The dam and the levees concentrated the area where spawning fish could hold and smolts could feed, and increased the potential for predation. While the annual construction of the dam has been discontinued, the levees are still in place. PRNS is currently acquiring these lands and developing a floodplain restoration plan. A phased restoration project requiring from five to ten years is planned to begin after final acquisition in 2007. Such restoration is expected to improve estuarine smolt and adult emigration habitat for both coho and steelhead.

The Coastal Watershed Restoration Project, proposed for nine sites within the Drakes Estero Watershed is planned for construction in 2006. The activities proposed through this project will remove or replace facilities such as road culverts and impoundments that impede natural freshwater and estuarine process. All treatment sites will meet fish passage design guidelines established by the NOAA Fisheries and CDFG (NOAA Fisheries, 2001; CDFG, 2003).

A large-scale wildfire could have moderate impacts on either species by removing riparian vegetation, increasing water temperature and removing upslope vegetation, with resultant increases in erosion and sedimentation. As noted above, the streams in which coho and steelhead exist in the study area are often in narrow, confined valleys with steep, vegetated slopes. A large, hot wildfire in such a valley would be difficult to suppress, and could quickly destroy riparian or slopeside vegetation. Suppression activities could also have short-term moderate effects through retardant drops and resultant changes in water quality.

Western Snowy Plover. Along the California coast, western snowy plovers have been extirpated from 33 of 53 nesting sites since 1970, and now number approximately 1,400 birds (USFWS, 1993). Although it is not one of the eight areas that support 78 percent of the California coastal breeding population, PRNS is 1 of only 20 remaining plover breeding areas in coastal California (USFWS, 1993). The Point Reyes peninsula is one of the largest relatively undisturbed beach habitats on the California coast, providing a large area of potential snowy plover habitat free of

threats that have impaired habitat elsewhere, such as development, ORV use, and heavy visitor use.

Fledging rates for snowy plovers before nest protection began were insufficient to maintain the species at PRNS, as indicated by declining numbers of nests and nesting adults in the period 1986-1995. Continuation of such low nest success rates could have resulted in loss of the PRNS breeding population of snowy plover. The current nest protection program has raised nest success rates to levels similar to those at other coastal California locations (USFWS, 1999a), but would be costly to maintain indefinitely.

Myrtle's Silverspot Butterfly. The largest numbers of Myrtle's silverspot butterflies documented in the early 1990s occurred on private land in the vicinity of Estero de San Antonio in Marin County northeast of PRNS. A golf course development proposed at that time was withdrawn, and the area is currently ranchland grazed by cattle and sheep. It is given a measure of protection from development by Marin County's agricultural zoning and policies to maintain the integrity of ranchlands in the western half of the county. Several of the ranches in the habitat area have sold development rights to the MALT, an organization seeking to preserve agricultural land in western Marin County. Any proposed development would have to comply with requirements of the ESA to protect the Myrtle's silverspot.

While it is difficult to determine the status of Myrtle's silverspot population at PRNS given current information, the species does not appear to be at risk of extinction in the near future (Launer et al., 1992; A. Launer, Stanford University, pers. com.). Cattle grazing has been identified as only one of a number of possible reasons for the species decline, but is also considered valuable in maintaining Myrtle's silverspot habitat.

Cattle grazing has been identified as only one of a number of possible reasons for the species decline, but is also considered valuable in maintaining Myrtle's silverspot habitat. While several areas have been identified where grazing may be adversely affecting the species' habitat at PRNS, overall grazing management has helped maintain a variety of plant cover conditions in Myrtle's silverspot habitats.

Conclusion

All known individuals of the seven federally listed as threatened and endangered plant species in the study area occur in the Minimum Management Fire Management Unit, and so would not be subject to either prescribed burning or mechanical fuels treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur in wet sites, within pastures routinely grazed by cattle, or on beaches or rocky outcroppings where fire is unlikely to carry.

Plant species that are not federally listed, but are of concern would likely continue to receive minor long-term benefits from prescribed burning and mechanical treatment, and the eventual return of natural fire cycles. Some patches or individuals of these species may experience minor, adverse effects from destruction through fire or suppression, or from the inadvertent stimulation of invasive exotic species from burning.

Prescribed fire and mechanical treatments would offer negligible to minor, long-term benefits on a limited scale to northern spotted owls, red-legged frogs, and California freshwater shrimp (the latter from fire only) by reducing the threat of catastrophic fire and the habitat destruction it would bring. Mechanical treatments such as hand thinning and pile burning to manage prescribed fire would have a minor, short-term, adverse effect on owls through possible human disturbance, reduction of prey species, and habitat alteration in unknown roosting and nesting sites, and on frogs from inadvertently killing individuals. No mechanical treatment is planned in the Bolinas FMU, in which habitat of the freshwater shrimp occurs. Large-scale wildfires could have more serious adverse effects on owls by eliminating habitat, and on frogs by burning riparian vegetation and increasing sedimentation. Both these species experience a positive cumulative impact from the large blocks of conservation land adjacent to the study area.

Adverse impacts to coho salmon and steelhead trout from prescribed burning would be negligible to minor, as riparian vegetation would be retained. Negligible positive benefits from reducing the risk and extent of a catastrophic burn would result from both prescribed burning and mechanical thinning. A large-scale wildfire would have more serious adverse effects by increasing siltation of streams and burning riparian vegetation, which in turn would increase water temperature.

Both Myrtle's silverspot butterfly and snowy plovers occur only in the Minimum Management FMU, and so would not be subject to either prescribed burning or mechanical fuel treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur within pastures routinely grazed by cattle (silverspot) or beach areas (plover) where fire is unlikely to carry.

The impacts of fire management activities, including those of average size and intensity wildfires in the study area on Point Reyes mountain beaver would be kept to no more than minor and short-term through the use of mitigation measures. Large-scale wildfires could have moderate adverse impacts that may be long-term.

There would be some indirect long-term benefits by conducting research and fire education. There are no adverse impacts to special status species by the construction of the fire cache.

No impairment to park special status species would occur from implementing Alternative A.

Alternative B

Impacts on Federally Listed Plant Species

Analysis

All of the plants identified above in Alternative A as on the federal list of threatened and endangered species are located primarily in the Minimum Management FMU, which is not treated by prescribed fire or mechanical thinning. These species include the Sonoma spineflower, Robust spineflower, Tiburon paintbrush, Marin dwarf flax, beach layia and Tidestrom's lupine.

Although this FMU may have some small wildfires, on average no more than about 30 acres of the entire study area burns in a given year. Since most of these plants are located in well grazed pastures or rocky outcrops, they are unlikely to be burned by wildfires in the park in average years. The impacts of Alternative B are the same as Alternative A on all of these species, with the exception of Sonoma alopecurus, which does occur in the Palomarin FMU. It is treated separately below.

Sonoma alopecurus (Alopecurus aequalis var. sonomensis) – Endangered
Sonoma alopecurus is a perennial grass that grows in the park primarily on pastures in agricultural areas. It favors moist or wet sandy soils.

Other Special Status Plant Species

Analysis

Under Alternative B, 9 FMUs are treated for a total of up to 2,000 acres per year. Estero, Inverness Ridge, Limantour, Wilderness North, Wilderness South, Highway One, Inverness Ridge, and Palomarin FMUs would be treated with both prescribed fire and mechanical thinning. Tomales Point would only be mechanically treated, and Bolinas Ridge FMU treated only with prescribed fire.

Prescribed Fire

As noted in the analysis in Alternative A, fire is an integral part of the natural ecosystem at Point Reyes and likely plays a critical role in the management of many plant and animal species of concern by maintaining open areas or stimulating reproduction. Prescribed burning may kill some individuals of these species, but it would also remove competitive non-native species and would have a beneficial impact in the long-term because of this. While this benefit would remain minor, it could conceivably be double or more that of Alternative A depending on the location of populations of each species. For example, Alternative B would use prescribed fire to treat areas in Inverness Ridge FMU, Wilderness South, and Palomarin FMUs. All of these FMUs have Marin manzanita, a species considered rare and declining inside the park because it requires fire to flourish. Adverse impacts would also be no more than minor and short-term, but could be more severe or widespread than in Alternative A, again because additional acreage would be burned.

Unplanned Ignitions, Wildfire, and Suppression

No changes in impacts from unplanned ignitions, average annual wildfires or their suppression are expected in this alternative from those described for Alternative A.

Mechanical Treatments

Mechanical treatment is not expected to have any adverse impacts on special status plants as mowing would be done in the fall and rare plants populations would be excluded from treatment areas.

Fire Information/Education

No impact to any plant special status species is expected from the distribution of fire information or education.

Fire Cache/Park Headquarters Relocation, and Construction

Because the area where the fire cache is planned would be surveyed prior to construction, impacts to protected plant species would be minimized. It is possible that individuals would be affected, but the extent of the effect would be minor.

Fire Effects and Fuel Management Research

No specific effects to any special status plant species from fuel management research under Alternative A are expected. However, small controlled burns in Bolinas Ridge and Palomarin FMUs would be conducted to determine post-burn species richness of native plants, and to determine if reducing the density of non-native species is possible using prescribed fire. Two special status plant species occur in these two FMUs. Although the federally endangered Sonoma alopecurus did occur at one time in the Palomarin FMU, this population has been extirpated.

Federally Listed Wildlife

Northern Spotted Owl (Strix occidentalis caurina) - Threatened

Under Alternative B, potential effects on northern spotted owls are greater than Alternative A because additional FMUs are being treated that are considered habitat. Two additional FMUs to be treated, in particular, Wilderness North and South, have considerable spotted owl habitat, and owls nest in the Inverness Ridge FMU as well.

Prescribed Fire

As noted in Alternative A, fuels have built up in spotted owl habitat making catastrophic, stand-replacing fire more likely. Such as fire would destroy spotted owl habitat for many years; prescribed burning is considered an important tool in helping to reduce these unnatural accumulations of fuels and ladder fuels and preserve owl habitat.

Preparatory burns and mechanical fuel reduction would be used to control fire intensity in areas in owl habitat, and no treatment would occur within 400 meters of a nesting or known roosting site. Prescribed fire planning also takes into account other important habitat components, such as down, woody debris that provide habitat for dusky-footed woodrats, which are an important prey species for northern spotted owls in the project area. If a prescribed burn does reduce the amount of woody debris, or would otherwise adversely affect woodrat habitat or nests, it would have an indirect minor, short-term, adverse effect on spotted owls.

Currently, no program elements exist for the management of prescribed fires for the benefit of spotted owls. The use of prescribed fire under Alternative B, would, nonetheless, have a beneficial, long-term, and minor impact on northern spotted owls, primarily through reduction in the threat of catastrophic fire in some areas.

Unplanned Ignitions, Wildfire, and Suppression

No impacts different than those described above for Alternative A would result from unplanned ignitions, wildfires or suppression in Alternative B. To sum, because average annual acreage burned from wildfires at the park is quite low, any more than minor adverse impacts from average annual wildland fires is unlikely.

Mechanical Treatments

Under Alternative B, hand thinning or mechanical treatments in the vicinity of development and roads such as on Bolinas Ridge, Wilderness North, Wilderness South, and Highway One FMUs could have an adverse effect on spotted owls if canopy closure was substantially reduced. This is especially true where developed areas interface with dense forest that provides roosting and nesting habitat. Under Alternative B, cutting large trees would be limited because techniques would be confined to hand thinning and then piling and burning. In some areas, clearing understory vegetation could, in fact, improve foraging conditions for spotted owls and habitat for it prey item - woodrats. Overall, impacts would remain localized and therefore minor.

Chipping over a wider area of the park and in more owl habitat than in Alternative A would be conducted under Alternative B. Chipping cut material and then distributing it over a site could occur where air quality, visitor use, or other management concerns prohibit burning. The equipment used to chip material is extremely loud and, if operated nearby, may disturb spotted owls. Although more chipping would take place in this alternative, impacts to owls would still be localized and temporary, and would therefore be no more than minor.

Fire Information/Education

No impact to spotted owls from the distribution of fire information or education is expected.

Fire Cache/Park Headquarters Relocation, and Construction

The fire cache would not be located in the vicinity of spotted owl activity centers or potential habitat, so no impact is expected.

Fire Effects and Fuel Management Research

No effects to spotted owls from fuel management research under Alternative B are expected.

Red-legged Frog (Rana aurora draytonii) – Threatened

Analysis

Prescribed Fire

Prescribed fire, because it is used to restore the natural vegetation structure of park habitats and reduce the risk of catastrophic fire, would have a long-term benefit to red-legged frogs and their habitat. Although this benefit would remain somewhat limited, it would be greater than Alternative A. In particular, frogs in the Palomarin, Inverness Ridge, Wilderness South, and Wilderness North FMUs would be benefited, as these FMUs are not subject to prescribed fire in alternative A.

High levels of fuel loading in some areas may cause prescribed fires to burn at higher than natural intensities, even when fire prescriptions were designed to minimize high-intensity fires. Higher intensity burns could inadvertently kill individual frogs or dry out pond habitat or vegetation the frogs need to move between ponds. They could also increase sedimentation. However, the extent of these types of impacts under the prescribed burn program proposed in this alternative would be quite small, or perhaps even largely non-existent, and adverse impacts would be negligible. In addition, burn plans in frog habitat would be reviewed and important frog habitat avoided if prescribed fire would be damaging.

Unplanned Ignitions, Wildfire, and Suppression

The same short-term and negligible adverse impacts from small wildfires as described in Alternative A would be possible in this alternative as well.

Mechanical Treatment

Mechanical treatment such as hand thinning, line construction, and pile burning could disturb frogs or alter their habitat. However, impacts would be no more than negligible because breeding areas and adjacent non-breeding areas would be identified and avoided before any mechanical treatment is taken.

Reduction in fuel loading by hand thinning or mechanical treatment would have a negligible, long-term, beneficial effect on red-legged frogs by reducing fuel loads and the threat of catastrophic fire.

Central California Coast Coho Salmon (Oncorhynchus kisutch) – Threatened and Central California Steelhead (Oncorhynchus mykiss) - Threatened

Central California coast coho salmon and Central California steelhead (hereafter referred to as coho and steelhead) occur in several creeks on the Point Reyes peninsula and in the Lagunitas Creek watershed that drains portions of PRNS and GGNRA. In addition to treatments in the Bolinas Ridge, Highway One, Estero, and Limantour Road FMUs, five new treatment areas are

identified in Alternative B. The Wilderness North FMU is included in the Tomales Bay, Drakes Bay, and Drakes Estero watersheds. The Wilderness South FMU is included in the Drakes Bay, Olema Creek, and Pine Gulch Creek watersheds. The Inverness Ridge FMU is included in the Drakes Estero and Tomales Bay Watersheds. The Palomarin FMU is located in the Drakes Bay and Bolinas Drainage watersheds. The Tomales Point FMU is located on the Tomales Bay and Pacific Drainage watersheds (see Figure 16). Designated critical habitat for coho in PRNS includes all accessible estuarine and stream areas in the coastal watersheds of Marin County except areas above longstanding, naturally impassable barriers or above Peters Dam on the mainstem of Lagunitas Creek and Seeger Dam on Nicasio Creek (NMFS, 1999). Although critical habitat has not been established for central California steelhead, it is likely to be the same as that for coho in Marin County.

Tomales Bay Watershed

Under Alternative B, the Limantour Road, Wilderness North, and Inverness Ridge FMUs would be subject to mechanical treatment and prescribed fire. The Tomales Point FMU would be subject to mechanical treatment. These FMUs represent 8% of the total watershed area (see Table 42).

Lagunitas Creek Watershed

Treatment under Alternative B would be the same as under Alternative A.

Olema Creek Watershed

Under Alternative B, the Bolinas Ridge FMU would be subject to prescribed fire while the Highway One FMU would receive both prescribed fire and mechanical treatment within the Olema Creek watershed. These FMUs encompass 20% of the total watershed area (see Table 42).

Drakes Bay Drainages

Under Alternative B, the Limantour Road, Palomarin, Wilderness North, and Wilderness South FMUs would be subject to mechanical treatment and prescribed fire. These FMUs represent 20% of the total watershed area (see Table 42).

Drakes Estero Watershed

Under Alternative B, the Estero, Limantour Road, Inverness Ridge, and Wilderness North FMUs would be subject to mechanical treatment and prescribed fire. These FMUs represent 31% of the total watershed area (see Table 42).

Pacific Drainages

The Pacific drainages do not support threatened salmonid species. Under Alternative B, the Tomales Point FMU would be subject to mechanical treatment.

Bolinas Drainages

Under Alternative B, the Bolinas Ridge FMU would be subject to prescribed fire while the Highway One and Palomarin FMUs would receive both prescribed fire and mechanical treatment within the Bolinas Drainages. These FMUs represent 33% of the total watershed area (see Table 42).

Pine Gulch Creek

Under Alternative B, the Bolinas Ridge FMU would be subject to prescribed fire while the Highway One and Wilderness South FMUs would receive both prescribed fire and mechanical treatment within the Pine Gulch Creek watershed. These FMUs represent 26% of the total watershed area (see Table 42).

Analysis

Under Alternative B, the treatments proposed could affect coho salmon and steelhead trout because eight of the nine FMUs to be treated have one or both species of fish. Highway One FMU has the greatest potential for possible impacts because of its proximity to Olema Creek and Pine Gulch Creek. The FMU surrounds the road corridor and includes more than 8 kilometers of mainstem habitat supporting coho salmon and steelhead trout.

Prescribed Fire

Prescribed fire is more controllable than wildfires, and through the use of mitigation measures identified in the review of each burn plan, impacts would be minimized so they are no more than negligible or minor. For example, riparian vegetation is important in protecting fish and keeping water temperatures lower. Burn plans for fires where coho or steelhead habitat is present would include a no-treatment buffer to protect riparian vegetation. Research indicates leaving a buffer would eliminate any increases in water temperature during or following burning (McMahon and deCalesta, 1990).

High levels of fuel loading in some areas of the park may create hot spots, or prescribed fires that burn at higher than natural intensities. This would decrease over time as more and more acreage is cumulatively treated, but could cause increased run-off and nutrient loads, even when fire prescriptions are designed to minimize high-intensity fires. Some fish species can begin to experience stress at relatively low sediment concentrations of 50 mg/l, but salmonids are know to thrive even in highly turbid rivers. The impacts from any increases in sediment loading resulting from prescribed burning are likely to be no more than minor, and would be short-term, lasting only until slopes are revegetated.

In addition to mitigation measures identified in Alternative A, Mitigation Measure S-2 would need to be considered for treatments in the Bolinas Drainages, Olema Creek, and Pine Gulch Creek watersheds, where the 1,000 acre potential annual treatments exceed more than 10% of the total watershed area. Mitigation Measure S-2 would be triggered when proposed actions have the potential to exceed 10% of the total area of one or more FMP watersheds in one year, which

could result in a minor to moderate impact to salmonids in a given watershed. Mitigation Measure S-2 assures that planning considers the watershed scale and, if a potential effect is identified, that specific adjustments to the burn density and schedule are included in the workplan. As shown in Table 42, the combined project acreage must exceed 790 acres in Bolinas Drainages, 939 acres in Olema Creek Watershed, and 506 acres in Pine Gulch Watershed.

Once it is confirmed that an annual plan for prescribed burning would exceed the 10% level of area in these smaller watersheds, Mitigation Measure S-2 requires an interdisciplinary team evaluation, chaired by the Fire Management Officer, to document the plan and identify actions that may reduce the potential burn or mechanical treatment impacts either spatially or temporally.

Prescribed fire, because it is used to restore the natural vegetation structure of park habitats and reduce the risk of catastrophic fire, would have long-term benefits for coho and steelhead by protecting dense riparian habitat for these two species, maintaining vegetated slopes and keeping water temperature in appropriate ranges. This benefit would be limited by the relatively small area that would be burned annually (1000 acres) under Alternative B, but over time this benefit could become quite widespread. Compared to negligible benefits offered under Alternative A, benefits to coho and steelhead from prescribed burning in this alternative would be long-term and minor.

Unplanned Ignitions, Wildfire, and Suppression

No impacts beyond those described for Alternative A from unplanned ignitions or their suppression would be expected.

Mechanical Treatment

Hand thinning and pile burning actions taken to manage prescribed fire would have no-effect or negligible adverse effect on coho and steelhead trout and would not increase sedimentation. The impact is considered negligible or minor because riparian areas and 100 foot buffer strips would not be treated and would reduce or eliminate any sedimentation increase. The benefits offered by mechanical treatment in this alternative by reducing the risk of a catastrophic fire would be greater than those in Alternative A because double the number of acres would be treated.

California Freshwater Shrimp (Synacaris pacifica)- Endangered

The California freshwater shrimp is found in a portion of the main stem of Lagunitas Creek in the Bolinas Ridge FMU.

Analysis

Prescribed Fire

The most important features of the environment inhabited by this species in the park are likely to be the continued presence of a structurally diverse stream environment and slower flowing or pooled water. Each of these is dependent on the presence of intact riparian vegetation. As noted above in the discussion of federally listed fish species and red-legged frogs, prescribed burning is generally not conducted in riparian vegetation. If a particular prescribed fire in the Bolinas Ridge FMU may affect riparian vegetation along Lagunitas Creek, park staff would make use of mitigation measures or other standard practices to ensure no habitat of the California freshwater shrimp is affected either directly or indirectly. In addition, prescribed fire, because it is used to restore the natural vegetation structure of park habitats and reduce the risk and possible extent of catastrophic fire, could offer long-term benefits for shrimp. Because the benefit to shrimp would be localized to sections of the Lagunitas Creek and would cover a small area, they would not be greater than minor as defined in the Methodology section. These benefits could be short- or long-term, depending on whether the treated areas return to natural fire intervals quickly or need additional treatment.

Unplanned Ignitions, Wildfire, and Suppression

No impacts beyond those analyzed in Alternative A would be expected from unplanned ignitions or their suppression in this alternative.

Mechanical Treatment

No mechanical treatment of Bolinas Ridge FMU is planned for this alternative. Therefore, no impact to California freshwater shrimp is anticipated.

Myrtle's Silverspot Butterfly (Speyeria zerene myrtleae) – Endangered

All of the occurrences of Myrtle's silverspot are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuels treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur within pastures routinely grazed by cattle where fire is unlikely to carry.

Western snowy plover (Charadrius alexandrinus nivosus) – Threatened

All of the occurrences of western snowy plovers are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuel treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the plovers occur in beach areas where fire is unlikely to carry.

Additional Special Status Wildlife

As noted above in Alternative A, Pt. Reyes Mountain Beaver is treated separately because it is more likely than other additional special status wildlife species to experience impacts from fire management activities.

Point Reyes Mountain Beaver (Aplondontia rufa phaea)

Analysis

Prescribed Fire

As noted above in the discussion of impacts to mountain beaver from prescribed burning in Alternative A, mountain beaver would be helped rather than harmed by prescribed fire in their habitat. In fact, small burns in mountain beaver habitat are used as mitigation for the effects wildfire can bring when fuels build up. This species was severely affected by the 1995 Vision wildfire, and prescribed burns would reduce the risk and extent of this kind of catastrophic fire recurring. Prescribed burns can also stimulate the growth of forbs and succulent plants used as food by mountain beaver. In this alternative, twice the acreage as in Alternative A would be treated with prescribed burning, including in Inverness Ridge FMU, where mountain beaver habitat exists and was burned in the Vision Fire.

Unplanned Ignitions, Wildfire, and Suppression

Unplanned ignitions and wildfires can burn hotter than prescribed burns, and so can cause major vegetation changes. The mitigation measures identified above would help keep unplanned ignitions from becoming large-scale wildfires, and with them in place impacts to mountain beavers are expected to remain negligible or minor. No changes in impacts from those described in Alternative A are therefore expected from average scope wildfires in the study area.

Mechanical Treatment

Impacts to mountain beavers from noise and the presence of humans during thinning or chipping operations could cause minor adverse impacts. Although these impacts would be more widespread than in Alternative A, they would remain localized and temporary. Mechanical thinning would also reduce the risk of catastrophic wildfire and offer minor benefits to mountain beavers in this regard.

Other Wildlife Species of Concern (excluding Mountain Beaver)

Analysis

Prescribed Fire

Same as Alternative A, adverse and beneficial impacts would also be no more than minor and short-term, but could be more widespread than in Alternative A, again because additional acreage would be burned.

Unplanned Ignitions, Wildfire, and Suppression

No changes in impacts from unplanned ignitions, average annual wildfires or their suppression are expected in this alternative from those described for Alternative A.

Mechanical Treatments

Same as Alternative A, adverse and beneficial impacts would also be no more than minor and short-term, but could be more widespread than in Alternative A, again because additional acreage would be burned.

Effects of Fire Information/Education on Special Status Wildlife

No changes from the possible slight benefits to special status wildlife from fire information and education described in alternative A would occur if this alternative were implemented.

Effects of Fire Cache/Park Headquarters Relocation, and Construction on Special Status Wildlife

No differences between the impacts of Alternative A and this alternative from the building of the fire cache are expected.

Fire Effects and Fuel Management Research on Special Status Wildlife

No differences between the impacts identified in Alternative A and this alternative from fire effects or fuel management research are expected.

Cumulative Impacts

No differences between the cumulative impacts identified in Alternative A and this alternative are expected.

Conclusion

Regarding plants that are federally listed as threatened and endangered species, all of the occurrences of Sonoma alopecurus, Sonoma spineflower, Tiburon paintbrush, Marin dwarf flax,

beach layia, and Tidestrom's lupine are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuels treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur in wet sites within pastures routinely grazed by cattle where fire is unlikely to carry.

Plant species that are not federally listed, but are of concern would likely continue to receive minor, long-term benefits from prescribed burning and mechanical treatment, and the eventual return of natural fire cycles. Some patches or individuals of these species may experience minor, adverse effects from destruction through fire or suppression, or from the inadvertent stimulation of invasive exotic species burning may sometimes have.

Prescribed fire and mechanical treatments would offer minor, long-term benefits on a limited scale to northern spotted owls, red-legged frogs, and California freshwater shrimp (from fire only) by reducing the threat of catastrophic fire and the habitat destruction it would bring. Mechanical treatments such as hand thinning and pile burning actions taken to manage prescribed fire would have a minor, short-term, adverse effect on owls through possible human disturbance, reduction of prey species, and habitat alteration in unknown roosting and nesting sites, and on frogs from inadvertently killing individuals. No mechanical treatment is planned in the Bolinas FMU, habitat of the freshwater shrimp. Large-scale wildfires could have more serious adverse effects on owls by eliminating habitat, and on frogs by burning riparian vegetation and increasing sedimentation. Both these species experience a positive cumulative impact from the large blocks of conservation land adjacent to the study area.

Adverse impacts to coho salmon and steelhead trout from prescribed burning would be negligible to minor, as riparian vegetation would be retained. Minor positive benefits from reducing the risk and extent of a catastrophic burn would result from both prescribed burning and mechanical thinning. A large-scale wildfire would have more serious adverse effects by increasing siltation of streams and burning riparian vegetation, which in turn would increase water temperature.

Both Myrtle's silverspot butterfly and snowy plovers occur only in the Minimum Management FMU, and so would not be subject to either prescribed burning or mechanical fuel treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur within pastures routinely grazed by cattle (silverspot) or beach areas (plover) where fire is unlikely to carry.

The impacts of fire management activities, including those of average size and intensity wildfires in the study area on Point Reyes mountain beaver would be kept to no more than minor and short-term through the use of mitigation measures. Large-scale wildfires could have moderate adverse impacts that may be long-term.

There would be some indirect long-term benefits by conducting research and fire education. There are no adverse impacts to special status species by the construction of the fire cache.

No impairment to park special status species would occur from implementing Alternative B.

Alternative C

Impacts on Federally Listed Plant Species

Analysis

All of the plants identified above in Alternative A as on the federal list of threatened and endangered species are located primarily in the Minimum Management FMU, which is not treated by prescribed fire or mechanical thinning. These species include the Sonoma spineflower, Robust spineflower, Tiburon paintbrush, Marin dwarf flax, beach layia, and Tidestrom's lupine. Although this FMU may have some small wildfires, on average no more than about 30 acres of the entire study area burns in a given year. Since most of these plants are located in areas in well grazed pastures or rocky outcrops, they are unlikely to be burned by wildfires in the park in average years. The impacts of Alternative B are the same as Alternative A on all of these species, with the exception of Sonoma alopecurus, which does occur in the Palomarin FMU. It is treated separately below.

Sonoma alopecurus (Alopecurus aequalis var. sonomensis) – Endangered

Sonoma alopecurus is a perennial grass that grows in the park primarily on pastures in agricultural areas. It favors moist or wet sandy soils.

Other Special Status Plant Species

Analysis

Under Alternative C, 10 FMUs are treated for a total of 3,500 acres. Compared to Alternative B, prescribed fire would be used to treat two additional FMUs - Tomales Point and Headlands. Mechanical treatment would be used in the same FMUs as in Alternative B. Five additional special status plant species of concern grow in the Headlands FMU. These species are perennial goldfields, Point Reyes meadowfoam, North Coast phacelia, Point Reyes rein orchid, and beach starwort.

Prescribed Fire

As noted above, fire is an integral part of the natural ecosystem at Point Reyes and likely plays a critical role in the management of many plant and animal Species of Concern by maintaining open areas or stimulating reproduction. Prescribed burning may kill some individuals of these species, but it would also remove competitive non-native species and therefore would have a beneficial long-term impact. While this benefit would remain minor, it could conceivably be triple or more that of Alternative A depending on the location of populations of each species. Adverse impacts from loss of individuals or small patches of special status plants would also be no more than minor and short-term, but could be more severe or widespread than in Alternative A or B, again because additional acreage would be burned. Prescribed burns in both Tomales Point and Headlands FMUs would be kept small (less than 50 acres), and carefully monitored to

determine the response of plant communities, including plants of special concern. In particular, the burns would be monitored to see if they reduce the aerial extent of invasive non-native plants and increase the percentage of natives in the headlands communities.

Unplanned Ignitions, Wildfire, and Suppression

No changes in impacts from unplanned ignitions, average annual wildfires, or their suppression are expected in this alternative from those described for Alternative A.

Mechanical Treatments

Mechanical treatment would be used to accomplish the same objectives in this alternative as in Alternative B - that is, primarily to help control non-native species and to prepare wooded areas for prescribed burning. Although the extent of mechanical treatment would increase in this alternative over both A and B, it is not expected have any adverse impacts on special status plants as mowing would be done in the fall and rare plants populations would be excluded from treatment areas.

Fire Information/Education

No impact to any plant special status species is expected from the distribution of fire information or education.

Fire Cache/Park Headquarters Relocation, and Construction

Because the area where the fire cache is planned would be surveyed prior to construction, impacts to protected plant species would be minimized. It is possible that individuals would be affected, but the extent of the effect would be minor.

Fire Effects and Fuel Management Research

In addition to small controlled burns in Bolinas Ridge and Palomarin FMUs to increase native species richness, a study of the effects of prescribed burning on fragrant fritillary in Limantour Road FMU would take place under this alternative. Also, the effects of both prescribed burning and mechanical treatment on Marin manzanita would be assessed in the Wilderness South FMU. If treatment is successful, minor positive benefits to these species could result in the long run.

Special-Status Wildlife

Northern Spotted Owl (Strix occidentalis caurina) – Threatened

Prescribed Fire

Under Alternative C, potential effects on northern spotted owls are greater than Alternative A because more acres (1,500) are being treated that are considered habitat and possible disturbance could occur.

As noted in Alternative A, fuels have built up in spotted owl habitat to the point that a catastrophic, stand-replacing fire is more likely. Such as fire would destroy spotted owl habitat for many years; prescribed burning is considered an important tool in helping to reduce these unnatural accumulations of fuels and ladder fuels and preserve owl habitat.

Preparatory burns and mechanical fuel reduction would be used to control fire intensity in areas in owl habitat, and no treatment would occur within 400 meters of a nesting or known roosting site. Spring prescribed fires in the moist conditions of old growth forests would also minimize damage, yet reduce fuel loads (Weatherspoon et al., 1992). Prescribed fire planning also takes into account other important habitat components, such as down, woody debris that provide habitat for dusky-footed woodrats, which are an important prey species for northern spotted owls in the project area. If a prescribed burn does reduce the amount of woody debris, or would otherwise adversely affect woodrat habitat or nests, it would have an indirect minor, short-term, adverse effect on spotted owls.

Currently, no program elements exist for the management of prescribed fires for the benefit of spotted owls. The use of prescribed fire under Alternative C, would, nonetheless, have a beneficial, long-term, and minor impact on northern spotted owls, primarily through reduction in the threat of catastrophic fire in some areas.

Unplanned Ignitions, Wildfire, and Suppression

No impacts different than those described above for Alternative A would result from unplanned ignitions, wildfires or suppression in Alternative C. To sum, because average annual acreage burned from wildfires at the park is quite low, any more than minor adverse impacts from average annual wildland fires is unlikely.

Mechanical Treatments

Under Alternative C, hand thinning or mechanical treatments in the vicinity of development and roads such as on Bolinas Ridge, Wilderness North, Wilderness South, and Highway One FMUs could have an adverse effect on spotted owls if canopy closure was substantially reduced. This is especially true where developed areas interface with dense forest that provides roosting and nesting habitat. Under Alternative B, cutting large trees would be limited because techniques would be confined to hand thinning and then piling and burning. In some areas, clearing understory vegetation could, in fact, improve foraging conditions for spotted owls and habitat for it prey item - woodrats. Overall, impacts would remain localized and therefore minor.

Chipping conducted under Alternative C would be greater than Alternative A or B. Chipping cut material and then distributing it over a site could occur where air quality, visitor use, or other management concerns prohibit burning. The equipment used to chip material is extremely loud and, if operated nearby, may disturb spotted owls. Although more chipping would take place in this alternative, impacts to owls would still be localized and temporary, and would therefore be no more than minor.

Fire Information/Education

No impact to spotted owls from the distribution of fire information or education is expected.

Fire Cache/Park Headquarters Relocation, and Construction

The fire cache would not be located in the vicinity of spotted owl activity centers or potential habitat, so no impact is expected.

Fire Effects and Fuel Management Research

No effects to spotted owls from fuel management research under Alternative C are expected.

Red-legged Frog (Rana aurora draytonii) – Threatened

Analysis

Prescribed Fire

Prescribed fire, because it is used to restore the natural vegetation structure of park habitats and reduce the risk of catastrophic fire, would have a long-term benefit to red-legged frogs and their habitat. Because red-legged frogs are widely disturbed among several FMUs in the study area, the benefits of prescribed burning and returning habitat to a more natural fire intensity and interval could be moderate.

As noted in Alternatives A and B, until broad areas have been treated, fuel loading may remain high and prescribed fires may burn at higher than natural intensities, even when fire prescriptions were designed to minimize high-intensity fires. These fires could kill individual frogs or have short-term adverse effects on frog habitat. Because of monitoring and avoidance of known frog habitat, adverse impacts would be negligible.

Unplanned Ignitions, Wildfire, and Suppression

The same short-term and negligible adverse impacts from small wildfires as described in Alternative A would be possible in this alternative as well.

Mechanical Treatment

Mechanical treatment such as hand thinning, line construction, and pile burning could disturb frogs or alter their habitat. However, impacts would be no more than negligible because breeding areas and adjacent non-breeding areas would be identified and avoided before any mechanical treatment is taken.

Reduction in fuel loading by hand thinning or mechanical treatment would have a negligible, long-term, minor effect on red-legged frogs by reducing fuel loads and the threat of catastrophic fire.

Central California Coast Coho Salmon (Oncorhynchus kisutch) – Threatened and Central California Steelhead (Oncorhynchus mykiss) - Threatened

Central California coast coho salmon and Central California steelhead (hereafter referred to as coho and steelhead) occur in several creeks on the Point Reyes peninsula and in the Lagunitas Creek watershed that drains portions of PRNS and GGNRA. In addition to treatments in the Bolinas Ridge, Highway One, Estero, Limantour Road, Wilderness North, Wilderness South, Inverness Ridge, Palomarin, and Tomales Point FMUs, one new treatment area is identified in Alternative C. The Headlands FMU is included in the Drakes Bay and Pacific Drainage watersheds(see Figure 16). Designated critical habitat for coho in PRNS includes all accessible estuarine and stream areas in the coastal watersheds of Marin County except areas above longstanding, naturally impassable barriers or above Peters Dam on the mainstem of Lagunitas Creek and Seeger Dam on Nicasio Creek (NMFS, 1999). Although critical habitat has not been established for central California steelhead, it is likely to be the same as that for coho in Marin County.

Tomales Bay Watershed

Under Alternative C, all treatment would be the same as those evaluated in Alternative B.

Lagunitas Creek Watershed

Under Alternative C, the Bolinas Ridge FMU would be subject to prescribed fire and mechanical treatment. This FMU represents 3% of the total watershed area (see Table 42).

Olema Creek Watershed

Under Alternative C, all treatment would be the same as those evaluated in Alternative B.

Drakes Bay Drainages

Under Alternative C, most treatments would be the same as those evaluated in Alternative B. In addition, the Headlands FMU would be subject to prescribed fire. These FMUs represent 24% of the total watershed area (see Table 43).

Drakes Estero Watershed

Under Alternative C, all treatment would be the same as those evaluated in Alternative B.

Pacific Drainages

The Pacific drainages do not support threatened salmonid species. Under Alternative C, most treatments would be the same as those evaluated in Alternative B. In addition, the Headlands FMU would be subject to prescribed fire.

Bolinas Drainages

Under Alternative C, all treatment would be the same as those evaluated in Alternative B.

Pine Gulch Creek

Under Alternative C, all treatment would be the same as those evaluated in Alternative B.

Analysis

Under Alternative C, the treatments proposed could affect coho salmon and steelhead trout because eight of the ten FMUs to be treated have one or both species of fish. Highway One FMU has the greatest potential for possible impacts because of its proximity to Olema Creek and Pine Gulch Creek. The FMU surrounds the road corridor and includes more than 8 kilometers of mainstem habitat supporting coho salmon and steelhead trout. Although these are the same FMUs with these species as are treated in Alternative B, more acres would be affected and so the potential for impact, both positive and adverse, is greater.

Prescribed Fire

As in other alternatives, mitigation measures including S-1 and S-2, identified in the review of each burn plan, to evaluate the erosion control plan and retain riparian vegetation would keep adverse impacts from prescribed fire minimized so they are no more than negligible or minor. Initially, high levels of fuel loading in some areas of the park may create hot spots, or prescribed fires that burn at higher than natural intensities, with resulting increases in sedimentation. This would decrease over time at a rate that is faster in this alternative than any other as more and more acreage is cumulatively treated. The impacts from any increases in sediment loading resulting from prescribed burning are likely to be no more than minor, and would be short-term, lasting only until slopes are revegetated.

Prescribed fire, because it is used to restore the natural vegetation structure of park habitats and reduce the risk of catastrophic fire, would have long-term moderate benefits for coho and steelhead by protecting dense riparian habitat for these two species, maintaining vegetated slopes, controlling sediment, and keeping water temperature in appropriate ranges.

Unplanned Ignitions, Wildfire, and Suppression

No impacts beyond those described for Alternative A from unplanned ignitions or their suppression would be expected.

Mechanical Treatment

Hand thinning and pile burning actions taken to manage prescribed fire would have no-effect or negligible adverse effect on coho and steelhead trout and would not increase sedimentation. The impact is considered negligible or minor because riparian areas and 100 foot buffer strips would not be treated and would reduce or eliminate any sedimentation increase. The benefits offered by mechanical treatment in this alternative by reducing the risk of a catastrophic fire would be greater than those in Alternative A or B and would approach moderate levels as defined in Methodology because these benefits would be widespread.

California Freshwater Shrimp

The California freshwater shrimp is found in a portion of the main stem of Lagunitas Creek in the Bolinas Ridge FMU.

Analysis

Prescribed Fire

As noted above, prescribed burning is generally not conducted in riparian vegetation. If a particular prescribed fire in the Bolinas Ridge FMU may affect riparian vegetation along Lagunitas Creek, park staff would make use of mitigation measures or other standard practices to ensure no habitat of the California freshwater shrimp is affected either directly or indirectly. In addition, prescribed fire, because it is used to restore the natural vegetation structure of park habitats and reduce the risk and possible extent of catastrophic fire, could offer benefits for shrimp. Because these benefits could extend over the entire range of shrimp habitat in the park, they may be long-term and moderate as defined in the Methodology section.

Unplanned Ignitions, Wildfire, and Suppression

No impacts beyond those analyzed in Alternative A would be expected from unplanned ignitions or their suppression in this alternative.

Mechanical Treatment

No mechanical treatment in Bolinas Ridge FMU is planned under Alternative C.

Myrtle's Silverspot Butterfly (Speyeria zerene myrtleae) – Endangered

All of the occurrences of Myrtle's silverspot are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuels treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur within pastures routinely grazed by cattle where fire is unlikely to carry.

Western snowy plover (Charadrius alexandrinus nivosus) – Threatened

All of the occurrences of western snowy plovers are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuel treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the plovers occur in beach areas where fire is unlikely to carry.

Other Wildlife Species of Concern

Mountain beaver is treated separately in this section because it may experience impacts from fire management activities.

Point Reyes Mountain Beaver (Aplondontia rufa phaea)

Analysis

Prescribed Fire

As noted above in the discussion of impacts to mountain beaver from prescribed burning in Alternative A, mountain beaver would be helped rather than harmed by prescribed fire in their habitat. In fact, small burns in mountain beaver habitat are used as mitigation for the effects wildfire can bring when fuels build up. This species was severely affected by the 1995 Vision wildfire, and prescribed burns would reduce the risk and extent of this kind of catastrophic fire recurring. Prescribed burns can also stimulate the growth of forbs and succulent plants used as food by mountain beaver. In this alternative, 2000 acres would be treated with prescribed burning, including in Inverness Ridge FMU, where mountain beaver habitat exists and was burned in the Vision Fire. Small prescribed burns conducted over a wide area of beaver habitat would result in minor benefits by maintaining suitable habitat and reducing potential for catastrophic wildfire.

Unplanned Ignitions, Wildfire, and Suppression

Unplanned ignitions and wildfires can burn hotter than prescribed burns, and so can cause major vegetation changes. The mitigation measures identified above would help keep unplanned ignitions from becoming large-scale wildfires, and with them in place impacts to mountain beavers are expected to remain negligible or minor. No changes in impacts from those described in Alternative A are therefore expected from average scope wildfires in the study area.

Mechanical Treatment

Impacts to mountain beavers from noise and the presence of humans during thinning or chipping operations could cause minor adverse impacts. Although these impacts would be more widespread than in Alternative A, they would remain localized and temporary. Mechanical

thinning would also reduce the risk of catastrophic wildfire and offer minor benefits to mountain beavers in this regard.

Other Wildlife Species of Concern (excluding Mountain Beaver)

Analysis

Prescribed Fire

Same as Alternative A, adverse and beneficial impacts would also be no more than minor and short-term, but could be more widespread than in Alternative A and Alternative B, because additional acreage would be burned under Alternative C.

Unplanned Ignitions, Wildfire, and Suppression

No changes in impacts from unplanned ignitions, average annual wildfires or their suppression are expected in this alternative from those described for Alternative A.

Mechanical Treatments

Same as Alternative A, adverse and beneficial impacts would also be no more than minor and short-term, but could be more widespread than in Alternative A and Alternative B, again because additional acreage would be treatment by mechanical means.

Effects of Fire Information/Education on Special Status Wildlife

No changes from the possible slight benefits to special status wildlife from fire information and education described in alternative A would occur if this alternative were implemented.

Effects of Fire Cache/Park Headquarters Relocation, and Construction on Special Status Wildlife

No differences between the impacts of Alternative A and this alternative from the building of the fire cache are expected.

Fire Effects and Fuel Management Research on Special Status Wildlife

No differences between the impacts identified in Alternative A and this alternative from fire effects or fuel management research are expected.

Cumulative Impacts

No differences between the cumulative impacts identified in Alternative A and this alternative are expected.

Conclusion

Regarding plants that are federally listed as threatened and endangered species, all of the occurrences of Sonoma alopecurus, Sonoma spineflower, robust spineflower, Tiburon paintbrush, Marin dwarf flax, beach layia, and Tidestrom's lupine are within the Minimum Management Fire Management Unit, and would not be subject to either prescribed burning or mechanical fuels treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur in wet sites within pastures routinely grazed by cattle where fire is unlikely to carry.

Plant species that are not federally listed, but are of concern would likely continue to receive minor long-term benefits from prescribed burning and mechanical treatment, and the eventual return of natural fire cycles. Some patches or individuals of these species may experience minor, adverse effects from destruction through fire or suppression, or from the inadvertent stimulation of invasive exotic species burning may sometimes have.

Prescribed fire and mechanical treatments would offer moderate, long-term benefits on a limited scale to northern spotted owls, red-legged frogs, and California freshwater shrimp (from fire only) by reducing the threat of catastrophic fire and the habitat destruction it would bring. Mechanical treatments such as hand thinning and pile burning actions taken to manage prescribed fire would have a minor, short-term, adverse effect on owls through possible human disturbance, reduction of prey species, and habitat alteration in unknown roosting and nesting sites, and on frogs from inadvertently killing individuals. No mechanical treatment is planned in the Bolinas FMU, habitat of the freshwater shrimp. Large-scale wildfires could have more serious adverse effects on owls by eliminating habitat, and on frogs by burning riparian vegetation and increasing sedimentation. Both these species experience a positive cumulative impact from the large blocks of conservation land adjacent to the study area.

Adverse impacts to coho salmon and steelhead trout from prescribed burning would be negligible to minor, as riparian vegetation would be retained. Moderate benefits from reducing the risk and extent of a catastrophic burn would result from both prescribed burning and mechanical thinning. A large-scale wildfire would have more serious adverse effects by increasing siltation of streams and burning riparian vegetation, which in turn would increase water temperature.

Both Myrtle's silverspot butterfly and snowy plovers occur only in the Minimum Management FMU, and so would not be subject to either prescribed burning or mechanical fuel treatments. The populations could be subject to impacts associated with an unplanned wildfire or by fire suppression activities, but this is unlikely because the populations occur within pastures routinely grazed by cattle (silverspot) or beach areas (plover) where fire is unlikely to carry.

The impacts of fire management activities, including those of average size and intensity wildfires in the study area on Point Reyes mountain beaver would be kept to no more than minor and short-term through the use of mitigation measures. Large-scale wildfires could have moderate adverse impacts that may be long-term.

There would be some indirect long-term benefits by conducting research and fire education. There are no adverse impacts to special status species by the construction of the fire cache.

No impairment to park special status species would occur from implementing Alternative C.

IMPACTS TO CULTURAL RESOURCES

Alternative A

Analysis

Several factors influence the degree of damage a cultural resource might experience as a result of the actions in a particular alternative. Some of these factors are discussed below for the actions of prescribed or wildland fire (direct effects), operations such as the use of equipment during thinning (operational effects), and from actions that result from fire or mechanical thinning, called "indirect effects." Indirect effects occur later in time than the fire itself but result from the fire or thinning. Examples of indirect effects include erosion of artifacts following the loss of vegetation in a fire, long-term deterioration of a structure related to damage initially suffered during a fire, etc.

The intensity of a fire and susceptibility of resources to heat is one factor that ultimately determines the degree of damage from the direct effect of fire. For example, obsidian hydration rinds are generally impacted at temperatures in excess of 100 to 150° C, dimensional lumber ignites at 350° C, glass melts at around 500° C, and cast iron at 1400° C. The degree to which duration of heating plays a role is less well understood, but in general, the longer a resource is exposed to heat, the greater the likelihood of damage. Fire can result in the complete elimination of an artifact or feature (e.g., through consumption), or can alter attributes of an artifact or feature such that important research (e.g., obsidian hydration rinds, residues on pottery, bone burning) is hindered, or traditional (e.g., Native American spiritual sites), or other values are impacted.

Fires tend to burn in a complex manner depending on fuels, weather, and terrain (Ryan and Noste, 1985). Fire intensity is generally greater under conditions of heavier fuel (e.g., dead and down timber, brushfields), low fuel moisture, high air temperatures, high winds, low humidity, and/or rugged terrain. It is the behavior of a fire (ground, surface, and crown) and proximity to a cultural resource that determines the amount and type of damage that could occur. While running surface fires and crown fires reach extreme temperatures (500 to 1500° C) and have high energy release rates, relatively little of that heat is directed towards the surface of the ground, and ground fires can result in long duration heating (400 to 700° C) within the upper 15 cm. of the soil profile. Only under rare conditions (e.g., burning tree roots) will elevated temperatures penetrate more deeply beneath the ground surface. Ground or creeping active surface fires are usually associated with prescribed burns, whereas running surface and crown fires occur primarily during wildfires. Very generally, cultural resources located above the ground surface (e.g., rock imagery panels, historical structures) are most vulnerable to direct fire effects during crown and active surface fires, while ground and creeping surface fires threaten those found at or just below the ground surface (e.g., archeological sites). Because of this, the chances of

adversely affecting a high percentage of cultural resources found exclusively on or near the ground surface are often greater. This is significant because cultural resources generally considered to have high data potential, such as Native American villages with subsurface components, may actually have a far lower percentage of artifact classes or attributes exposed to direct fire effects than a lithic scatter, often considered to have low data potential that is restricted to the ground surface. While it is the village that would probably receive the greatest amount of attention in regard to a planned or unplanned fire management action, it is the lithic scatter that has the potential to undergo the greatest intensity of impact.

In general, direct effects of fire management actions on cultural resources would be adverse. This is particularly true of archeological resources, structures, and museum objects. While direct fire effects can also adversely impact ethnographic resources and cultural landscapes, fire can also be used to restore, enhance and maintain them. For example, in regard to ethnographic resources, some plants important for basketmaking benefit from the proper application of fire (Anderson, 1999). In cultural landscapes with a vegetation component, fire can be applied to replicate and maintain historic scenes. Adverse direct effects are more likely to occur during extreme fire behavior such as wildfires, although cultural resources with high vulnerability to fire are susceptible to low intensity burns often associated with prescribed fire.

Operational effects to cultural resources are most likely to occur as a result of fire management actions associated with prescribed burns, wildfires and mechanical thinning. The operational effects on cultural resources have been quantified in only a relatively few cases. However, several generalizations can be made:

Impacts resulting from the operation of heavy equipment on and in close proximity to cultural resources will correlate directly with the nature and extent of the disturbance, nature of local sediments, and nature and extent of cultural resources. Heavy equipment would not be used except to help extinguish a wildfire.

With the exception of those that result in more intense fire behavior (e.g., slash piles, firing techniques), impacts resulting from operational effects would generally be restricted to the displacement, breakage and/or destruction and looting of cultural resources. In this sense, operational effects tend to be less encompassing than direct effects. For example, an obsidian projectile point displaced by construction of a fire line would probably retain its hydration rind, morphology, and other attributes.

Except in rare situations, operational effects are likely to be most pronounced on cultural resources found on and near the ground surface.

Operational effects would be most likely to occur, and at the greatest intensity, during wildfires. This is due primarily to the fact that such actions are often carried out with little or no pre-planning and without consultation or supervision by a cultural resource specialist.

Operational effects of fire management actions on cultural resources would, in most cases, be adverse. However, the degree of impact depends greatly on the nature of the operation and the cultural resource or resources in question. Adverse operational effects are of particular concern

during and after wildfire events. With proper planning, operations can also be used for beneficial purposes. For example, mechanical thinning can effectively remove hazardous fuels from and in the vicinity of cultural resources, as well as restore, enhance or maintain ethnographic resources and cultural landscapes, in cases where the risk of direct effects is too high.

Indirect effects may be delayed and incremental, and are related most strongly to the intensity of the fire management effort, although context and the nature of the resource play important roles. For example, intense fire behavior and major suppression efforts associated with wildfires would often mean indirect effects, such as loss through erosion, would occur relatively quickly and to a larger degree than following a smaller prescribed burn or mechanical thinning. Over time, these smaller actions can have adverse consequences of similar magnitude to wildfire suppression. The indirect effects of fire management actions related to high intensity wildfires would be generally adverse.

As noted in Affected Environment, cultural resource surveys as Point Reyes are not 100% complete. The areas that are less likely to have been surveyed are those that are difficult to access, either because of rugged topography, thick vegetation or both. Because these areas have not been surveyed, they are vulnerable to the loss of resources and information during what could be quite intense burns. On the other hand, settlement in the area has by in large taken place where topography is less steep, along fresh and saltwater sources, and vegetation is not dense, and it is these areas where cultural resource data is more likely to have been recorded. The combination of less dense vegetation and more intense surveys in these areas mean these resources are not likely to suffer more than minor or moderate impacts, even in a wildland fire.

Mitigation Measures

Mitigation measures are actions that reduce the impact of the planned activities on a particular resource. In this case, all of the measures listed below would be employed at Point Reyes National Seashore, and would be part of agreements between state and federal cultural resource protection agencies and the NPS. They are divided in measures taken before actions in the alternatives (prescribed fire or thinning, suppression of unplanned ignitions) occur, during these actions and following them. Because they are mandatory, the alternatives are analyzed assumed each would be put into place.

Pre-Action

Cultural resources would be considered during all fire management planning efforts.

Fire management personnel and other staff would receive annual training on cultural resources and fire management actions.

All cultural resources would be evaluated with respect to hazardous fuel loads. As needed, fuel loads would be reduced using methods commensurate with avoiding or minimizing adverse effects. Maintaining light fuel loads on and in close proximity to cultural resources would be

emphasized. All areas slated for ground disturbing activities would be subjected to pre-action field surveys. This includes areas likely to be disturbed during future wildfires.

Pre-burn survey would be conducted prior to all prescribed burns as dictated by resource distribution and vulnerability, vegetation and topography, and expected fire behavior.

Consultation with local Native American communities would continue to occur in the context of fire management actions. Spiritual sites and important plant communities would be identified and appropriately managed for preservation, maintenance, and/or enhancement.

Computer and other databases containing cultural resources data would be created and maintained, and made available to fire management personnel in the event of emergencies.

Cultural resources specialists from adjacent land management agencies would be consulted in order to coordinate mitigation efforts prior to planned and unplanned fire management actions.

Appropriate cultural resources monitoring protocols would be established and implemented.

Potential research opportunities to study the effects of fire management actions on cultural resources would be identified.

During-Action

A cultural resource specialist or resource advisor would be present during all fire management actions where recorded and unrecorded resources of interest are considered at risk. Additional surveys would be conducted on an as-needed basis.

Observations of fire behavior and other variables would be made with respect to recorded cultural resources and/or areas with high probability of containing unrecorded cultural resources.

Cultural resources data would be shared with fire management personnel as needed to avoid or minimize adverse effects.

A cultural resource specialist or resource advisor would educate fire management personnel about cultural resources and the potential impacts of fire management actions.

Post-Action

The post-action condition of all recorded cultural resources would be assessed. Resources requiring stabilization or other treatment would be mitigated.

As appropriate, post-action survey would be conducted in previously surveyed and unsurveyed areas. Previously unrecorded cultural resources would be assessed for condition, and stabilization and other protection needs.

Monitoring and research data would be compiled, evaluated, and used to help refine cultural resource compliance for fire management actions.

Prescribed Fire

Under this alternative, a maximum of 500 acres/year, which would all be treated in Estero, Limantour Road, Highway One, and Bolinas Ridge FMUs, would be burned using prescribed fire. This is the same as under existing conditions.

Prescribed burning could offer some benefits to cultural resources. For example, areas that are to be burned are surveyed, and staff can locate and evaluate the significance of cultural resources they would not otherwise have had an opportunity or reason to assess. The ability to conduct pre-burn inventories also allows the park to quantitatively and spatially document fuel conditions and require mechanical treatment of particularly dense vegetation to avoid damage to important cultural sites. If this is not possible, the information about fuel conditions can be used to direct post-burn survey and more meaningfully assess damage to cultural resources that could not be mitigated prior to the burn. These benefits are expected to be minor because it is not expected that significant archeological or historic resources will be found. In addition, prescribed burns can be conducted in areas to obtain cultural landscape objectives, offering long-term and short-term moderate benefits if a landscape is restored. The benefit is moderate because prescribed burning could provide a measured change in the significant characteristic of the landscape. For example, prescribed burning could open up a historic view-shed (part of a cultural landscape) that has been lost because of vegetation growth.

Prescribed burns can also be used to improve conditions at or safety of a cultural resource, and in particular of historic buildings. For example it is possible, through varied timing or operational procedures (e.g., heading or backing fire) to achieve lower or higher fire intensities. A low intensity fire might be utilized on or immediately adjacent to a particular cultural resource such as a historic structure; while a high intensity fire could significantly reduce hazardous fuels surrounding the resource. Prescribed burns are implemented at times when the likelihood of escape is low, thereby minimizing potential effects to those cultural resources in close proximity to a burn unit. Reducing fuel loads from around historic structures could offer short-term moderate benefits for cultural resources.

As noted above, a standard mitigation measure for prescribed burns in the park is the presence of a cultural resource specialist, who would be able to monitor fire behavior and the effectiveness of mitigation measures during the burn for future reference. The specialist would also be on site in the case of an escape to help mitigate or minimize potential adverse effects of suppression.

Preparation activities, such as line construction, would also be monitored by a cultural resource specialist. The specialist would survey the site where these activities are planned and collaborate on the best location for them, monitor construction to ensure minimal damage, and brief fire personnel on the proper protocol in and around cultural resources. The presence of a specialist is likely to keep impacts to archeological sites from these activities low, so they are no more than minor and short-term.

The benefit of pre-burning planning allows the cultural resources specialist to account for potential indirect effects. For example, if high tree mortality is a concern following the burn, efforts can be taken to reduce the number of trees in proximity to a cultural resource. Some indirect effects like erosion are exacerbated by intense fire behavior, the type that is unlikely to occur over large areas during prescribed burns.

Unplanned Ignitions, Wildfire, and Suppression

Due to often extreme fire behavior, the direct effects of wildfires on cultural resources can be substantial, including adverse damage. However, at Point Reyes, an average of only three small (less than 10 acres/year) unplanned ignitions has taken place for most years, although very large fires can occur under unusual conditions. As these are unplanned events, cultural resource specialists rarely have the luxury of benefits conveyed by pre-planning efforts during wildfires. For example, because all of the park has not been intensely surveyed (approximately 87% of the park has not been surveyed; however, the 13% surveyed covers the most likely areas for archeological sites) of Point Reyes has been fully inventoried for cultural resources, it is highly likely that wildfires will occur in areas that lack or have few recorded cultural resources.

Information regarding direct effects would in most cases be obtained during the post-burn phase, and involve evaluating those effects on resources for which no pre-burn condition data were available. It is possible that an uncontrolled large wildfire could destroy or remove all information from cultural resources or have a short- or long-term effect on the integrity of cultural landscapes. See impacts section under Cumulative Impacts below.

Operational effects associated with wildfire suppression can often be adverse, major, and permanent. The acts of constructing fire lines with a dozer, helispots, staging areas, mopping-up and other ground disturbing processes can have major adverse permanent impacts on cultural resources, particularly those that are on the ground or buried. Even with low impact techniques, the placement of fire lines and related phenomenon can be quite unsystematic when compared to planned fire management actions. Although the use of heavy equipment for fire suppression is prohibited unless authorized by the Point Reyes superintendent, it is a standard tool for agencies charged with fire management on adjacent lands, and would almost certainly be employed in cases where life or property was at risk.

Large numbers of personnel, from varied backgrounds, are present at any fire. Crews are often spread across a vast area. Cultural resource looting and vandalism can potentially occur during wildfire events. However, these adverse impacts would be minor because most archeological sites have been recorded and surface artifacts removed. In addition, NPS resource advisors would be on-site quickly after a burn to ensure looting and vandalism does not occur.

During suppression activities some cultural landscape elements may be altered. However, most would be a temporary alteration that could be restored and most suppression activities would not alter a significant number of characteristics of a particular cultural landscape. Therefore, by suppression activities, cultural landscapes would have short-term, minor, adverse effects because a small percentage of the historic landscapes would likely to be lost and should not last more than 10 years.

To sum, from uncontrolled wildfire this alternative could have permanent adverse major effects to historic buildings due to loss during an uncontrolled wildfire. Archeological sites may receive permanent, adverse, major from suppression effort because heavy equipment such as a tractor and blade may inadvertently impact a archeological or historical site. Cultural landscapes would have only short-term, minor, adverse effects because a small percentage of the historic landscapes would likely to be lost and should not last more than 10 years. For impacts under a large-scale fire, see Cumulative Impacts section below.

Mechanical Treatments

Under this alternative, 500 acres/year in Estero, Limantour Road, Highway One, and Bolinas Ridge FMUs would be treated by mechanical means.

Although fire itself is not technically a component of mechanical treatments, prescribed burning of vegetation piles would be undertaken. Fuel loads in these piles would be substantial, would tend to burn at very high intensities, and any cultural resources found in proximity would almost certainly suffer direct effects. With the ability to pre-plan, the cultural resource specialist can ensure that piles are not created on or near cultural resources, and impacts would be no more than minor.

Operational effects present the greatest concern in regard to the potential impacts of mechanical treatment. Ground disturbance could result in substantial impacts to cultural resources. However, mechanical treatments offer the benefit of pre-planning in that the location(s) of ground disturbance can be specifically delineated, and known cultural resources avoided. In the event that an area cannot be subjected to adequate pre-burn survey due to thick vegetation, a cultural specialist could monitor the mechanical treatment for cultural resources that become exposed. Likewise, less intensive mechanical treatments can be employed in highly sensitive areas. While looting by fuels crews is also a concern, these effects could be minimized through a combination of education and avoiding known resources. Together, these activities would prevent impacts to archeological resources from mechanical thinning from becoming more than short-term and minor.

A variety of indirect effects could arise as a result of mechanical treatments. The use of heavy equipment could result in soil compaction, and potential soil erosion on and near cultural resources. The act of thinning vegetation on or near cultural resources might leave them vulnerable to looting. Again, however, the ability to perform pre-treatment survey means that equipment can be excluded from or near cultural resources and vegetation can be strategically left in place to discourage looting. Mechanical treatments also offer the potential short-term moderate benefit of reducing fuel loads in proximity to cultural resources. They would also offer long-term moderate benefits by restoring and/or maintaining historical scenes associated with structures and cultural landscapes, especially in situations where it is not desirable or possible to accomplish these tasks with the direct application of fire.

Fire Information/Education

Impacts associated with fire information and education would largely be beneficial, although highly dependent on the nature of the fire management action. Pre-planned events such as prescribed fires and mechanical treatment provide the opportunity to demonstrate the effectiveness of cultural resources compliance to local Native American communities and the interested public. During unplanned events, such as wildfires time for effective communication is often more limited and can be more controversial since resources are often damaged.

Fire Cache/Park Headquarters Relocation, and Construction

The construction of a fire cache at Bear Valley would have no influence on the direct effects of fire management actions on cultural resources. However, relocating fire management personnel to a more centralized location would allow for faster response time to cultural resources in the event of wildfires.

Operational effects associated with the construction of the new fire cache are unlikely to occur. The Bear Valley developed area has been surveyed in its entirety on several occasions (Kelly, 2003) and no cultural resources have been documented at the proposed fire cache location.

No adverse or beneficial indirect effects are anticipated with the construction of the new fire cache.

No adverse or beneficial effects are anticipated with the construction of the new fire cache on historic structures, archeological sites, or cultural landscapes.

Fire Effects and Fuel Management Research

No adverse or beneficial effects are anticipated on cultural resources from the implementation of Alternative A research projects. All historic structures, archeological sites, or cultural landscapes would be avoided and treated areas located away from any known sites.

Cumulative Impacts

Based on an analysis of the list of projects in Appendix C, the cumulative impacts of all the projects listed would not change the potential intensity or duration of the impacts to cultural resources. Most of the projects building projects listed have beneficial effects on cultural resources. However, a large-scale high-intensity, uncontrolled fire such as the 1995 Vision would dramatically increase all impacts to cultural resources (see impacts above). Extremely high fire temperatures can be expected, with the implication that even the most durable cultural resources are vulnerable to major, permanent damage. A large number of significant historic structures could be loss and soil erosion from hydrophobic soils could severely damage archeological resources. Large fires would often encompass a high number of cultural resources including historic structures, cultural landscapes, and archeological sites resulting in permanent, major, adverse cumulative effect.

Conclusions

Alternative A would have short-term, moderate, beneficial effects to historic buildings by reducing fuels around these structures, both through prescribed burns and mechanical treatment. Moderate, long-term, benefits to cultural landscapes from the restoration or maintenance of them through prescribed fire or mechanical treatments are also likely. Mitigation measures would keep impacts to archeological resources (from pre-treatment for prescribed burns, or mechanical thinning activities) from becoming more than short-term and minor.

Suppression activities associated even with smaller, more average sized wildfires could have negligible to major permanent major adverse effects to cultural resources because no pre-planning occurs and suppression, rather than resource protection, is the top priority. Archeological sites could have permanent adverse major from suppression effort because heavy equipment such as a tractor and blade may inadvertently impact an archeological or historical site. Cultural landscapes would have only short-term, minor, adverse effects from average wildfires because a small percentage of the historic landscapes would likely to be lost and should not last more than 10 years.

No adverse or beneficial effects are anticipated with the construction of the new fire cache or implementing research activities on historic structures, archeological sites, or cultural landscapes.

A large-scale uncontrolled wildfire as described in the Cumulative Impact section could have long-term, major, adverse effects to historic buildings and cultural landscapes due to significant loss of numerous historic features and structures. The alternative would not result in long-term impairment to cultural resources.

Alternative B

Analysis

The same type of activities as described above for Alternative A would take place. However, up to 1000 acres/year in 8 FMUs including Estero, Inverness Ridge, Limantour Road, Wilderness North, Wilderness South, Highway One, Bolinas Ridge, and Palomarin would take place. Mechanical treatments of 1000 acres/year could occur in FMUs at Tomales Point, Estero, Limantour Road, Wilderness North, Wilderness South, Highway One, and Palomarin. The same factors as described above would influence the degree of damage cultural resources might sustain, and the same mitigation measures would be applied to minimize this damage.

Prescribed Fire

Same as Alternative A, except 500 additional acres/year would be treated by prescribed fire. Therefore, beneficial effects to cultural landscapes and historic structures would be greater. Regarding archeological resources, the potential for a minor, short-term, adverse effect from inadvertently burning an archeological site would be greater. The potential for these impacts has

increased because prescribed fire would be used in Inverness Ridge, Wilderness North, Wilderness South, and Palomarin FMUs in addition to the four FMUs (Estero, Limantour Road, Highway One, and Bolinas Ridge) in Alternative A. Palomarin FMU probably has the greatest potential for additional archeological sites to be inadvertently impacted.

Unplanned Ignitions, Wildfire, and Suppression

The chance of an unplanned ignition or wildfire occurring in this alternative is very close to the same as in Alternative A, and the long-term, major, adverse impacts to historic structures or cultural landscapes from direct effects of the fire, and to archeological resources from suppression or mop-up would be the same as well.

Mechanical Treatments

The same types of impacts as described in Alternative A, both beneficial and adverse, would occur as a result of mechanical treatments. However, an additional 500 acres/year would be treated. Although the benefits to cultural landscapes and historic structures would be greater than in Alternative A, they would still be considered short-term and moderate. Also, although impacts to subsurface archeological resources from operations associated with mechanical treatment would potentially cover a wider area than in Alternative A, they would remain minor and short-term because of the implementation of the mitigation measures described above. However, the potential for these impacts has increased because mechanical treatment would be used in Tomales Point, Wilderness North, Wilderness South, and Palomarin FMUs in addition to the four FMUs (Estero, Limantour Road, and Highway One) in Alternative A.

Fire Information/Education

No differences compared to Alternative A in the benefits to fire education are anticipated from implementing Alternative B.

Fire Cache/Park Headquarters Relocation, and Construction

No differences compared to Alternative A in the impacts of constructing and operating a fire cache are anticipated from implementing Alternative B.

Fire Effects and Fuel Management Research

No additional benefits from conducting research identified as part of this alternative are expected compared to Alternative A.

Cumulative Impacts

No additional cumulative impacts beyond those described above for Alternative A are expected.

Conclusions

Alternative B would have short-term, moderate, beneficial effects to historic buildings by reducing fuels around these structures, both through prescribed burns and mechanical treatment. These benefits would be greater than in Alternative A, but would remain in the moderate category. Moderate long-term benefits similar but greater than in Alternative A to cultural landscapes from the restoration or maintenance of them through prescribed fire or mechanical treatments are also likely. As in Alternative A, mitigation measures would keep impacts to archeological resources from pre-treatment for prescribed burns, or mechanical thinning activities from becoming more than short-term and minor. However, the potential for these impacts is greater because both mechanical and prescribed fire programs are treating more FMUs.

A large-scale uncontrolled wildfire could have long-term, major, adverse effects to historic buildings and cultural landscapes. Suppression and/or mop-up of such a fire could have long-term, major, adverse effects to archeological resources. Suppression activities associated with more average wildfires could also have negligible to major impacts to cultural resources.

No adverse or beneficial effects are anticipated with the construction of the new fire cache or implementing research activities on historic structures, archeological sites, or cultural landscapes.

The alternative would not result in long-term impairment to cultural resources.

Alternative C

Analysis

This alternative would allow prescribed burning of 2000 acres/year in 10 FMUs including Tomales Point, Estero, Headlands, Inverness Ridge, Limantour Road, Wilderness North, Wilderness South, Highway One, Bolinas Ridge, and Palomarin and mechanical treatment in all except the Point Reyes Headlands for a total of 1,500 acres/year.

Prescribed Fire

Same as Alternative A, except 1,500 additional acres/year would be treated by prescribed fire for a total of 2000 acres/year. Therefore, beneficial effects to cultural landscapes and historic structures would be greater than A. Regarding archeological resources, the potential for a short-term adverse effect from inadvertently burning an archeological site would be greater than Alternative A or B. The impacts are moderate because they could affect a moderate percentage of significant resources; however, because of mitigation measures these resources still have low vulnerability. In addition, this alternative, above the eight treated in Alternative B) treats the Headlands and Tomales Point FMUs that have high potential for archeological resources.

Unplanned Ignitions, Wildfire, and Suppression

The chance of an unplanned ignition or wildfire occurring in this alternative is very close to the same as in Alternative A, and the long-term major adverse impacts to historic structures or cultural landscapes from direct effects of the fire, and to archeological resources from suppression or mop-up would be the same as well.

Mechanical Treatments

Same as Alternative A, except 1000 additional acres/year would be treated by mechanical means for a total of 1500 acres/year. Therefore, beneficial effects to cultural landscapes and historic structures would be greater than Alternative A and B. Regarding archeological resources, the potential for a short-term, adverse, effect from inadvertently mechanically treating an archeological site would be greater than Alternative A or B. The impacts are moderate because they could affect a moderate percentage of significant resources; however, because of mitigation measures these resources still have low vulnerability. In addition, this alternative, above the seven treated in Alternative B) treats the Inverness Ridge, Bolinas Ridge and Tomales Point FMUs that could have archeological resources that have not be surveyed or located.

Fire Information/Education

No differences compared to Alternative A in the benefits to fire education are anticipated from implementing Alternative C.

Fire Cache/Park Headquarters Relocation, and Construction

No differences compared to Alternative A in the impacts of constructing and operating a fire cache are anticipated from implementing Alternative C.

Fire Effects and Fuel Management Research

No additional benefits from conducting research identified as part of this alternative are expected compared to Alternative A.

Cumulative Impacts

No additional cumulative impacts beyond those described above for Alternative A are expected.

Conclusion

Actions included in Alternative C include prescribed burn projects encompassing up to 2000 acres/year, mechanical treatment projects covering up to 1500 acres/year and a suppression program. The fire cache would be located at park headquarter at Bear Valley and education and research are similar to Alternative A and B. Beneficial impacts of this alternative include the ability to pre-plan for increased prescribed burns and mechanical treatments. On the other hand,

additional prescribed burning means that those cultural resources vulnerable to direct fire effects could be adversely impacted in situations where adequate pre-burn survey and/or mitigation could not be employed. Among the beneficial impacts of this alternative are the ability to pre-plan for prescribed burns, mechanical treatments, defensible space, and road maintenance.

This alternative would result in short-term, moderate, beneficial effects from prescribed fire and mechanical thinning to historic buildings by reducing fuels around these structures. The effects would be greater than Alternative A and B. Archeological sites would experience short-term, moderate, adverse effects if an area were inadvertently impacted. The potential for these impacts to archeological resources is greater than Alternative A and B because more acres and FMUs are being treated. Cultural landscapes would have long-term, moderate, beneficial effects because historic landscapes such as grasslands could be perpetuated over time. The effects would be greater than Alternative A and B.

No adverse or beneficial effects are anticipated with the construction of the new fire cache on historic structures, archeological sites, or cultural landscapes.

Suppression of average sized wildfires could have negligible to major long-term, major, adverse effects to historic buildings or archeological sites. A major wildfire could have major long-term impacts from the loss of historic structures during burning, or archeological sites during suppression and mop-up. Cultural landscapes could experience long-term, major, adverse effects because historic landscapes could be dramatically changed by uncontrolled wildfire.

The alternative would not result in long-term impairment to cultural resources.

IMPACTS TO VISITOR USE AND THE VISITOR EXPERIENCE

Alternative A

Analysis

This alternative continues the current fire management program treating 500 acres by prescribed fire and 500 acres with mechanical means. There would continue to be visual and visitor experience impacts from fuel reduction projects underway, prescribed burns that are conducted annually in the spring and fall, and unplanned suppression activities. Two FMUs - Limantour and Highway 1 have areas within designated wilderness.

Prescribed Fire

Prescribed fire can be used as a tool to maintain visual quality and enhance the visitor experience, such as in maintenance of view sheds and cultural landscapes, and it can also have effects that would be considered potentially adverse to the visitor. Under Alternative A, prescribed fire would continue to be used infrequently as a tool for maintaining open scenic views. This acreage treated in three FMUs - Limantour, Highway One, and Bolinas Ridge would potentially increase scenic vistas from trails and major roadways. In this case, effects of

prescribed burning on visual resources would be generally beneficial and long-term, but minor, because of the limited number of acres treated.

Some visitors would see the local effects of burning as adverse, but public acceptance of the prescribed fire program has increased to the point that this view would be atypical. For those individuals that are adversely impacted by burned areas, visual impacts such as charred vegetation, blackened earth, or fire lines would be minor because burned areas become green and revegetated with a few months (often by the next winter).

Some visitors would also be impacted by noise from fire management actions, smoke, or the closure of an area (usually less than 200 acres and for one or two days) for a prescribed fire. Sources of noise during prescribed burns may include the operation of fire engines or other heavy equipment, which would move along roads and burn boundaries. A diesel truck traveling at 40 miles per hour at 50 feet can have sound levels of 80 dB (16 times as loud as reference loudness). Noise would be generated for less than 20 days each year on an average to complete projects.

Effects of closures on visitor activities, including hiking, nature study, and scenic touring, would generally be limited to small-scale and temporary restrictions. Visitors would remain able to recreate outside of the prescribed fire project boundary, and very few people would be unable to partake in their chosen activity, although some may need to experience them in another part of the park.

Smoke would affect a wider area, and thus more visitors, than closures and restrictions. However, because prescribed fires would be ignited only under certain atmospheric conditions, the effects of concentrated smoke would generally be localized.

In addition, some visitors expecting a wilderness experience may be adversely impacted from smoke, noise and the sight of a burned area; however, this impact would be short-term and minor.

Overall, effects on the visitor experience from activities associated with prescribed burning in this alternative would be adverse, short-term, and minor.

Unplanned Ignitions, Wildfire, and Suppression

Wildland fires would continue to burn approximately 30 acres per year on average, mostly along major roadways. To some, the effect of managed wildland fire on scenic resources would be seen as adverse. Other visitors would see the effects as beneficial and natural. Fire in plant communities that are within their natural range of variability rarely result in extreme events with major effects on visual or scenic quality. The typical effects of fire include blackened bark, cat faces on some trees, opening of the understory, cleaning (through burning) of the litter and duff layer, and the scorching of some trees, resulting in scattered kill and opening of the canopy. It is likely that some park users would see these as non-natural effects and they would consider them adverse visual impacts: however, the impact would be short-term and minor because of the small number of localized acres suppressed each year and the quick growth of new vegetation.

Holding Actions (water and retardant drops, helispots, and spike camps)

These actions have the potential to have short-term effects on visual resources, in the form of evidence of helispots and spike camps. These effects would be local in scale and probably not encountered by most visitors. Effects on visual quality and visitors would be adverse, short-term, and minor.

During wildland fire incidents, helicopters would be used as needed for reconnaissance, monitoring, and moving people and supplies. At least one flight per day would normally be flown over fires, many of which would be in wilderness. If the fire grows, the reconnaissance area and flight duration would increase as well. Helicopters 100 feet from a person would be as loud as 100 dB, a sound that would be uncomfortably loud. In relative terms, this would be 128 times as loud as an urban, daytime ambient noise level of 40 dB. Should it occur, the effect on visitors in the vicinity would be adverse, but since it would be localized and temporary, would remain minor. In addition, areas may be closed for short periods (less than five days) for unplanned wildfire suppression activities, but the adverse impacts to visitors would be minor and short-term.

Mechanical Treatment

Mowing, hand cutting, chipping and pile burning actions could adversely affect visitors in both the immediate area during treatment, and those who pass through or view the area shortly after treatment is completed. Mowing and hand cutting is currently used as a tool to reduce fuels around building and along Highway One FMU and in the Estero FMU. Noise from equipment, air emissions and the presence of human activity in natural areas are examples of short-term adverse impacts to visitors. Chainsaws in close proximity would be the loudest typical equipment, with sounds as loud as 100 dB. This noise, especially in a park setting, would be an adverse impact on the park visitor experience, but would be short-term and minor. Because some areas would be closed during mechanic treatments, the visitor would be impacted only a few days (less than 20 per year), and the impacts would be minor because they would be extremely localized.

Pile burning has two potential effects on visual quality. First, piles of stacked fuels would be visible, potentially within major scenic views. Second, piles once burned would leave a pattern of burned area that would appear unnatural. Both effects would be adverse, short-term, and minor because they would be small areas (less than five acres) that are burned and the piles would be burned and have new vegetation by the next winter.

The area treated would also appear different; this may be perceived as an adverse impact as well, although with public information and education, some visitors would view treatment as a beneficial impact. In either case, the impact would be minor, because vegetation would return quickly and the visual change would be localized.

In addition, some visitors expecting a wilderness experience may be adversely impacted from noise and the sight of a mechanically treated area; however, this impact would be short-term and minor.

Fire Information/Education

The PRNS has staff to assist with fire education to provide information to the visiting public and community. Providing information to the public to increase understanding of the objectives of the fire program would be beneficial, minor and long-term.

Fire Cache/Park Headquarters Relocation, and Construction

Relocation of the fire cache and construction in the present park headquarters compound would not have any adverse impacts to viewsheds. The construction of a new building would be completed with a site design that incorporates an appreciation of the green space in the headquarters area and the site is not accessible to the public. The relocation of the fire cache would be completed in an area formerly occupied by a trailer. Although some temporary adverse impacts associated with noise of construction are expected, this would be no more than minor and temporary.

Fire Effects and Fuel Management Research

The PRNS has staff to assist with fire research and document the effects of mechanical and prescribed fire treatments and provide this information to the visiting public and community. No impacts to visual resource would occur from fire research; however, providing information to the public to increase understanding of the objectives of the fire program would be beneficial, minor, and long-term.

Cumulative Impacts

There have been very few actions taken inside or outside the park in the past to affect the visitor experience. Past fire management and fuels treatment activities have resulted in burned areas, cut stumps, evidence of holding lines, burned area rehabilitation work, and others that some may view as adverse. Some of these impacts are potentially visible from highways entering the park such as Sir Francis Drake and Highway One, if passersby knew where to look for them.

Based on an analysis of the list of projects in Appendix C, the cumulative impacts of all the projects listed with this proposed action would have a minor adverse effect on park visual quality and the visitor experience. The projects listed do not have long-term impacts to visual quality or experience. However, a large-scale wildfire such as the Vision Fire would have a major adverse effect on visual quality and the visitor experience.

Under all alternatives, large, high-intensity, high severity fires would continue to occur infrequently in the park until the majority of the park is restored to its natural function. Because fires have been, and would continue to be, suppressed, fuels build up and the plant community structure changes. It is unlikely that this situation would change markedly during the life of this

revised Fire Management Plan. If these conditions resulted in a large, high severity fire, there may be both short and long-term major adverse impacts.

During catastrophic fires, large numbers of firefighting personnel and equipment would be deployed to control the fire, as needed. Helicopters, chain saws, and other sources of sometimes very loud noise could be used over very large areas for several days or weeks. During suppression actions that are brought about because of large, high severity fires, noise effects would be adverse, short-term, and major.

Over the longer term, scenic quality and recreational opportunities, including sightseeing, hiking in natural areas, and viewing wildlife, may experience large-scale changes that last for many years, resulting in major long-term adverse impacts under all alternatives.

Conclusion

Prescribed burning would have minor positive effects by opening and restoring scenic vistas, but to some visitors the short-term blackening of vegetation from prescribed fires may be a minor adverse effect. Smoke and closures would also have temporary, minor, adverse impacts on visitors.

Mechanical treatment may adversely affect nearby visitors through noise. Changes in the treated area from mowing or hand cutting would be adverse for some visitors, but beneficial for others. Pile burning may also cause localized changes that some visitors find to be negative and other positive. Overall, impacts from mechanical treatment would be short-term and minor, regardless of whether they are adverse or beneficial.

Actions to suppression wildfire have the potential to have short-term effects on visual resources, in the form of evidence of helispots and spike camps. These effects would be local in scale and probably not encountered by most visitors. Effects would be adverse, short-term, and minor.

Providing information to the public to increase understanding of the objectives of the fire program would be indirectly beneficial, minor, and long-term.

The relocation of the fire cache would have short-term adverse impacts to visitors from noise and dust associated with construction.

While construction projects or past fire management activities would have no more than minor short-term impacts to visitors, a large-scale wildfire could result in major adverse impacts to recreational activities or scenic quality for several years. Eventually, these resources would recover, and no permanent loss of their integrity, e.g., impairment, would occur.

Alternative B

Analysis

The impacts of this alternative on scenic resources would be similar to that of the No Action (Alternative A), except in the following areas:

Prescribed Fire

While Alternative B has no specific intent to use prescribed burning to improve scenic vistas or other components of the visitor experience, it would result in twice the acreage treated with prescribed fire as in Alternative A. It would also treat in four FMUs - Inverness Ridge, Wilderness North and South, and Palomarin - where treatment to reduce fuels could have side benefits to visitors by clearing scenic views from forest fuels that have become overstocked and degraded over the past century. Because these benefits would only occur in a small portion of the up to 1,000 acres treated each year, the potential to enhance visual resources would be only a minor benefit.

As noted above, these same changes could also be interpreted by some visitors, including backcountry visitors in this alternative, as negative. However, public acceptance of the prescribed fire program has increased to the point that changes in vegetation resulting from prescribed burning would not be seen as adverse by most visitors; education of visitors would continue this acceptance and perception of prescribed fire as a benefit. Even so, visual impacts such as charred vegetation, blackened earth and fire lines would be adverse, short-term, and minor to some park users.

Visitors would experience minor, short-term, adverse impacts from noise and smoke, and from closures, total up to 30 days in this alternative.

A detectable benefit to scenic or recreational resources by reducing the risk of destruction through catastrophic fire is likely with this alternative as well. Prescribed burning would be lower intensity than wildfire, resulting is fewer noticeable changes in scenery and the ultimate protection of visual resources. Over time, the benefit would be minor.

Unplanned Ignitions, Wildfire, and Suppression

No changes in impacts from unplanned ignitions, average annual wildfires, or their suppression from those described in Alternative A are expected.

Mechanical Treatments

This alternative increases mechanical treatment to 1000 acres, including highly scenic FMUs (Wilderness North and South, Tomales Point, and Palomarin). Treatment and closures would last for about 30 days each year. Noise from mowing, hand-cutting and chipping equipment, air emissions, and the presence of human activity in natural areas could have adverse, localized, short-term impacts on visitors. Because some areas would be closed during mechanic treatments,

visitors would be affected for only a few days (less than 30 per year) and impacts would be minor.

The same effects of pile burning described above would occur under this alternative over a wider area of the park. Because the burned areas would quickly revegetation, the impact would be short-term and minor.

The area treated would also appear different; this may be perceived as an adverse impact as well, although with public information and education, some visitors would view treatment as a beneficial impact. In either case, the impact would be minor, because vegetation would return quickly and the visual change would be localized.

Fire Information/Education

No changes in impacts from those described for Alternative A would be expected.

Fire Cache/Park Headquarters Relocation, and Construction

No changes in impacts from those described for Alternative A would be expected.

Fire Effects and Fuel Management Research

No changes in impacts from those described for Alternative A would be expected.

Cumulative Impacts

No changes in impacts from those described for Alternative A would be expected.

Conclusion

Prescribed burning would have minor positive effects by opening and restoring scenic vistas, but to some visitors the short-term blackening of vegetation from prescribed fires may be a minor adverse effect. Smoke and closures (up to 30 days) would also have temporary minor adverse impacts on visitors.

Mechanical treatment may adversely affect nearby visitors through noise (closures up to 30 days of small areas). Changes in the treated area from mowing or hand cutting would be adverse for some visitors, but beneficial for others. Pile burning may also cause localized changes that some visitors find to be negative and other positive. Overall, impacts from mechanical treatment would be short-term and minor, regardless of whether they are adverse or beneficial.

Actions to suppression wildfire have the potential to have short-term effects on visual resources, in the form of evidence of helispots and spike camps. These effects would be local in scale and probably not encountered by most visitors. Effects would be adverse, short-term, and minor.

Providing information to the public to increase understanding of the objectives of the fire program would be indirectly beneficial, minor, and long-term.

The relocation of the fire cache would have short-term adverse impacts to visitors from noise and dust associated with construction.

While construction projects or past fire management activities would have no more than minor short-term impacts to visitors, a large-scale wildfire could result in major adverse impacts to recreational activities or scenic quality for several years. Eventually, these resources would recover, and no permanent loss of their integrity, e.g., impairment, would occur.

Alternative C

Analysis

The impacts of this alternative on scenic resources would be similar to that of the No Action Alternative, except in the following areas:

Prescribed Fire

Under this alternative, prescribed fire would be significantly increased (2000 acres) and could be used as a major tool for restoring and maintaining scenic resources. Although PRNS does not have any specific plans in place to address scenic vistas, there are areas (Limantour, Highway One, Wilderness North and South FMU, Palomarin FMU) in which prescribed fire could be employed to improve aesthetics and vistas. This acreage would only be a small portion of the 2,000 acres per year treated on average for resource and hazardous fuel reduction, but the actions would clear scenic views of forests that have become overstocked and degraded over the past century. Prescribed fire would be used in all ten FMUs and have the potential to change the landscape character of an area and therefore has the potential to affect more visitors in the park. For visitors who perceive these changes and/or the use of prescribed fire as a tool to return systems to natural conditions, moderate benefits are possible in this alternative. For those who believe the changes are negative, moderate adverse impacts may result.

Short-term adverse impacts from blackened earth, charred vegetation, fire lines, smoke, and closures for up to 50 days could be moderate because of the larger number of acres treated.

A larger benefit to scenic or recreational resources by reducing the risk of destruction through catastrophic fire than in Alternatives A or B would result from implementing this alternative. Prescribed burning would be lower intensity than wildfire, resulting is fewer noticeable changes in scenery and the ultimate protection of visual resources. Over time, the benefit could be moderate.

Unplanned Ignitions, Wildfire, and Suppression

No changes in impacts from those described for Alternative A would be expected.

Mechanical Treatments

This alternative increases mechanical treatment to 1500 acres, including several highly scenic FMUs (Wilderness North and South, Tomales Point, and Palomarin). Treatment and closures would last for about 50 days each year. Noise from mowing, hand-cutting and chipping equipment, air emissions, and the presence of human activity in natural areas could have adverse, localized, short-term impacts on visitors. The combination of these short-term impacts from noise and closures may become quite noticeable and moderately adverse to visitors.

Pile burning would occur on cut fire lines as the primary method of brush disposal but on a much larger scale than in Alternative A and Alternative B. The piles of stacked fuels would be visible in the immediate area of work, and potentially within some scenic views. When burned, the piles would leave a pattern of burned area that would not appear natural. As in Alternative A and B, impacts would be adverse, short-term, and moderate.

The area treated would also appear different; this may be perceived as an adverse impact as well, although with public information and education, some visitors would view treatment as a beneficial impact. In either case, the impact would be minor to moderate, and vegetation would return quickly.

Fire Information/Education

No changes in impacts from those described for Alternative A would be expected.

Fire Cache/Park Headquarters Relocation, and Construction

No changes in impacts from those described for Alternative A would be expected.

Fire Effects and Fuel Management Research

No changes in impacts from those described for Alternative A would be expected.

Cumulative Impacts

No changes in impacts from those described for Alternative A would be expected.

Conclusion

Prescribed burning would have minor positive effects by opening and restoring scenic vistas, but to some visitors the short-term blackening of vegetation from prescribed fires may be a moderate adverse effect. Smoke and small closures of areas (up to 50 days) would also have temporary moderate adverse impacts on visitors.

Mechanical treatment may adversely affect nearby visitors through noise and small closures of areas up to 50 days. Changes in the treated area from mowing or hand cutting would be adverse for some visitors, but beneficial for others. Pile burning may also cause localized changes that

some visitors find to be negative and other positive. Overall, impacts from mechanical treatment would be short-term and moderate, regardless of whether they are adverse or beneficial.

Actions to suppression wildfire have the potential to have short-term effects on visual resources, in the form of evidence of helispots and spike camps. These effects would be local in scale and probably not encountered by most visitors. Effects would be adverse, short-term, and minor.

Providing information to the public to increase understanding of the objectives of the fire program would be indirectly beneficial, minor, and long-term.

The relocation of the fire cache would have short-term adverse impacts to visitors from noise and dust associated with construction.

While construction projects or past fire management activities would have no more than minor short-term impacts to visitors, a large-scale wildfire could result in major adverse impacts to recreational activities or scenic quality for several years. Eventually, these resources would recover, and no permanent loss of their integrity, e.g., impairment, would occur.

IMPACT TO PARK OPERATIONS

Alternative A

The park currently has about 115 full-time employees (FTEs) and an operating budget of approximately $4.9 million, excluding the fire budget. In addition, the park receives annually about $2.6 million in one-time funding from fees, and from special NPS funds for natural resource, education, cultural resource, and maintenance projects (maintenance projects include repair and rehabilitation funding for buildings).

Fire funding for operations is approximately $770,000 annually for wildfire suppression, mechanical treatments, and prescribed fire. For the last three years, Point Reyes and GGNRA have received an additional $700,000 annually for Wildland Urban Interface (WUI) projects. Staffing for all aspects for fire management is approximately 13 FTEs (Wong, 2003).

The total operations budget for Point Reyes is $5.67 million.

Analysis

Prescribed Fire

Under this alternative, 500 acres/year at FMUs Estero, Limantour Road, Highway One, and Bolinas Ridge would be treated with prescribed fire. Only actions described in the section Actions Common to All Alternatives, including road maintenance and brushing around buildings, would occur in the other FMUs. Because this is a continuation of existing practices, no additional funding or FTEs would be needed. Because the FMUs on Inverness Ridge, Palomarin, Wilderness North and South would not be treated, facilities at Five Brooks (horse campground, horse stables), housing along Inverness Ridge, and park facilities (Point Reyes Bird Observatory

Visitor Center and Commonweal housing) at Palomarin would be more susceptible to a large-scale fire. The reduction of hazardous fuels around park facilities in these FMUs would reduce the risk of a catastrophic fire and the potential for loss of a structure.

Unplanned Ignitions, Wildfire, and Suppression

The park relies heavily on Marin County Fire Department for structural fire and wildland fire protection. The NPS is considered support and back up for large-scale events. For the most part, this arrangement has been highly effective in controlling unplanned ignitions and wildfires. As noted in other sections of the EIS, on average the park has only three smaller unplanned ignitions (of about 10 acres) each year. Because the No Action alternative would continue this arrangement and level of effort, no additional funding or FTE is needed. Therefore no beneficial or adverse impacts are anticipated.

Mechanical Treatments

Under this alternative, 500 acres/year at FMUs Estero, Limantour Road, Highway One, and Bolinas Ridge would be treated by mechanical means. Actions in the other FMUs would be those described in the Actions Common to All Alternatives section of the EIS, including road maintenance and creating defensible space around structures. Because this is a continuation of existing practices, no additional funding or FTEs would be needed. Therefore no beneficial or adverse impacts are anticipated. Because the FMUs on Inverness Ridge, Palomarin, Wilderness North and South would not be treated, facilities at Five Brooks (horse campground, horse stables), housing along Inverness Ridge, and park facilities (Point Reyes Bird Observatory Visitor Center and Commonweal housing) at Palomarin would be more susceptible to a large-scale fire. The reduction of hazardous fuels around park facilities in these FMUs would reduce the risk of a catastrophic fire and the potential for loss of structures.

Fire Information/Education

The NPS has one staff and additional interns to assist with fire education. No change in this staffing level would occur under the No Action alternative.

Fire Cache/Park Headquarters Relocation, and Construction

The construction of a fire cache at Bear Valley would have a one-time cost of approximately $500,000. This is a one-time negligible adverse impact to the park's budget. Existing staff would be relocated to this facility. No additional operating costs are necessary. The park would receive operational benefits by having a facility and fire staff close to park headquarters. Having a fire cache at park headquarters would have beneficial effects on park operations; it would allow for more efficient use of staff time (At present, staff travel to and from Hagmaier Fire Cache; approximately 7 miles from Bear Valley.) and the fire program would be closer to the major park assets such as the Bear Valley Visitor Center and major maintenance facilities. In addition, there would be long-term minor beneficial effects by having a more energy efficient building.

Fire Effects and Fuel Management Research

No new staffing or funding is necessary; therefore no beneficial or adverse impacts would be anticipated.

Cumulative Impacts

Based on an analysis of the list of projects in Appendix C, the cumulative impacts of all the projects listed with this proposed action would have a negligible adverse effect on park operations and management. The projects listed do not require additional operating funds or staff except for minor adjustments to the park's operating budget. However, a large-scale wildfire such as the Vision Fire would have a short-term adverse major effect on park operations and management. The cost to suppress the Vision Fire is estimated to have been $6.4 million.

Conclusion

Because funding and staffing levels would remain the same for all aspects of the fire management program, no positive or adverse impacts to either are expected from No Action. The one time funding of a new fire cache would have a short-term negligible adverse impact to the park's budget, but would have long-term minor benefits in terms of fire management operations by creating new efficiencies.

The cumulative impacts of all the projects listed with this proposed action (except large-scale wildfire) would have a negligible adverse effect on park operations and management. Suppression of a large-scale wildfire would a short-term adverse major effect on park operations, management, and budget.

The alternative would not result in long-term impairment to park operations and management.

Alternative B

Alternative B would allow prescribed burning of 1000 acres/year in 8 FMUs including Estero, Inverness Ridge, Limantour Road, Wilderness North, Wilderness South, Highway One, Bolinas Ridge, and Palomarin.

Analysis

Prescribed Fire

To accomplish the level of treatment described above, $105,000 in additional funding and 1.5 FTEs would be needed (Wong, 2003). This is a 1.9% increase in funding compared to No Action, and a minor adverse impact on park operations and management. Because the FMUs on Inverness Ridge, Palomarin, Wilderness North and South are treated (above Alternative A), facilities at Five Brooks (horse campground, horse stables), housing along Inverness Ridge, and park facilities (Point Reyes Bird Observatory Visitor Center and Commonweal housing) at Palomarin would be less susceptible to a large-scale fire. The reduction of hazardous fuels

around park facilities in these FMUs would reduce the risk of a catastrophic fire and the potential for loss of a structure.

Unplanned Ignitions, Wildfire, and Suppression

As noted in Alternative A, the park relies heavily on Marin County Fire Department for structural fire and wildland fire protection and the NPS is considered support and back-up for large-scale events. The arrangement has worked well over all to suppress unplanned ignitions and keep wildfires to about 30 acres or less per year on average. Therefore no changes are anticipated and no beneficial or adverse impacts relative to No Action would occur.

Mechanical Treatments

Under this alternative, 1000 acres/year at FMUs Tomales Point, Estero, Limantour Road, Highway One, Wilderness North and South, and Palomarin would be treated by mechanical means. To accomplish this level of treatment, $105,000 in additional funding and 1.5 FTEs would be needed (Wong, 2003). This is a 1.9% increase in operation funding and a minor adverse impact on park operations and management. Because the FMUs on Tomales Point, Palomarin, Wilderness North and South would be treated by mechanical means (above Alternative A), facilities at Five Brooks (horse campground, horse stables), and park facilities (Point Reyes Bird Observatory Visitor Center and Commonweal housing) at Palomarin would be treated to be less susceptible to a large-scale fire. The reduction of hazardous fuels around park facilities in these FMUs would reduce the risk of a catastrophic fire and the potential for loss of structures.

Fire Information/Education

No changes in staffing or funding from those in No Action are anticipated.

Fire Cache/Park Headquarters Relocation, and Construction

As in Alternative A, the construction of a fire cache at Bear Valley would have a one-time cost of approximately $500,000. Existing staff would be located to this facility. No additional operating costs are necessary and some beneficial impacts to park operations would occur as described in Alternative A.

Fire Effects and Fuel Management Research

No new staffing or funding is necessary; therefore no beneficial or adverse impacts are anticipated.

Cumulative Impacts

No cumulative impacts except those described above for Alternative A would occur.

Conclusions

Small increases in budget in Alternative B to conduct additional prescribed burning and thinning would have minor adverse impacts to park operations and management compared to Alternative A. This alternative requires a $211,000 in annual operating funds, a 3.8% increase to overall park funding. The one time funding of a new fire cache would have a short-term, negligible, adverse impact to the park's budget, but would have long-term minor benefits in terms of fire management operations by creating new efficiencies.

The cumulative impacts of all the projects listed with this proposed action (except large-scale wildfire) would have a negligible adverse effect on park operations and management. Suppression of a large-scale wildfire would a short-term, adverse, major effect on park operations, management, and budget.

The alternative would not result in long-term impairment to park operations and management.

Alternative C

Alternative C would allow prescribed burning of 2000 acres/year in 10 FMUs including Tomales Point, Estero, Headlands, Inverness Ridge, Limantour Road, Wilderness North, Wilderness South, Highway One, Bolinas Ridge, and Palomarin and mechanical treatment in all except the Point Reyes Headlands for a total of 1,500 acres/year.

Analysis

Prescribed Fire

To accomplish the prescribed burning of 2000 acres/year in the FMUs described above, $227,000 in funding (3.9% increase) and 4.0 additional FTEs would be needed (Wong, 2003); therefore, there would be minor adverse impacts on park operations and management. Because the FMUs are treated, facilities at Five Brooks (horse campground, horse stables), housing along Inverness Ridge, and park facilities (Point Reyes Bird Observatory Visitor Center and Commonweal housing) at Palomarin would be less susceptible to a large-scale fire. In addition, treatment at Tomales Point would provide some protection to facilities at Pierce Point Ranch and treatments at the Headlands would provide some fire protection for the Lifeboat Station Complex. The reduction of hazardous fuels around park facilities in these FMUs would reduce the risk of a catastrophic fire and the potential for loss of a structure.

Unplanned Ignitions, Wildfire, and Suppression

As noted in Alternative A, the park relies heavily on Marin County Fire Department for structural fire and wildland fire protection and the NPS is considered support and back-up for large-scale events. The arrangement has worked well over all to suppress unplanned ignitions and keep wildfires to about 30 acres or less per year on average. Therefore no changes are anticipated and no beneficial or adverse impacts relative to No Action would occur.

Mechanical Treatments

Under this alternative, 1,500 acres/year at FMUs Tomales Point, Estero, Limantour Road, Highway One, Wilderness North and South, Highway One, Palomarin, and Bolinas Ridge would be treated by mechanical means. To accomplish this level of treatment, $113,000 in additional funding (1.9 % increase) and 1.0 FTEs would be needed (Wong, 2003); therefore, there would be minor adverse impacts on park operations and management. Because all the FMUs would be treated by mechanical means except the Headlands, facilities at Five Brooks (horse campground, horse stables), housing along Inverness Ridge, and park facilities (Point Reyes Bird Observatory Visitor Center and Commonweal housing) at Palomarin would be treated to be less susceptible to a large-scale fire. By treating Bolinas Ridge, the ability of the park to stop a fire from traveling from the east or west would be enhanced; therefore, facilities in Olema Valley would have greater protection. The reduction of hazardous fuels around park facilities in the FMUs listed would reduce the risk of a catastrophic fire and the potential for loss of structures.

Fire Information/Education

No changes in staffing or funding from those in No Action are anticipated.

Fire Cache/Park Headquarters Relocation, and Construction

As in Alternative A, the construction of a fire cache at Bear Valley would have a one-time cost of approximately $500,000. Existing staff would be located to this facility. No additional operating costs are necessary and beneficial impacts to park operations are anticipated as described in Alternative A.

Fire Effects and Fuel Management Research

No new staffing or funding is necessary; therefore no beneficial or adverse impacts are anticipated. However, because additional research is proposed, one-time research projects would need funding. Therefore, there would be a minor impact to the park's budget.

Cumulative Impacts

No cumulative impacts except those described above for Alternative A would occur.

Conclusions

An overall 5.9% increase in budget and additional 5 FTEs in staffing in Alternative C to conduct additional prescribed burning and thinning would have minor adverse impacts to park operations and management compared to Alternative A. These increases would be larger than in Alternative B. However, the beneficial impacts to providing fire protection for park facilities are greater than Alternative A and B. The one time funding of a new fire cache would have a short-term, negligible, adverse impact to the park's budget, but would have long-term minor benefits in terms of fire management operations by creating new efficiencies.

The cumulative impacts of all the projects listed with this proposed action (except large-scale wildfire) would have a negligible adverse effect on park operations and management. Suppression of a large-scale wildfire would a short-term adverse major effect on park operations, management, and budget.

The alternative would not result in long-term impairment to park operations and management.

IMPACTS TO HUMAN HEALTH AND SAFETY

Alternative A

Human health may be affected by prescribed burning and wildland fire through the inhalation of smoke. During a prescribed burn, visitors would remain outside the area through the use of temporary trail closures, signing, public information about the fire, and other temporary closures of areas and facilities. In the case of an "average" wildland fire (e.g., the park on average experiences fires in fewer than 30 acres), visitors or community members may require evacuation. In either case, they would not be exposed to the fire itself and safety risks would be minimized. However, firefighting personnel would be much closer to either prescribed burns or wildland fires, and so may be subject to increased risk to their safety.

All individual wildland fire use and prescribed fire projects would be managed under the same conditions and constraints under all alternatives. Each project would be implemented only with the concurrence of the Bay Area Regional Air Quality Control District, and managed to maintain smoke emissions in communities below the legal thresholds as defined by the State of California and the Environmental Protection Agency. Because of these restrictions, alternatives with more acres burned under prescription, and therefore where timing, placement and conditions under which they burn, would be more successful at minimizing smoke impacts over the long-term.

Analysis

Prescribed Fire

The principal effect of FMP activities on public health is generation of smoke, especially particulate matter, from prescribed fires and unintended wildland fire. Particulate matter, found in the air-liquid droplets and small solid particles of minerals and soot can penetrate deep into the lungs because it is small. In smoke, roughly 80% of the particulate matter is smaller than 2.5 micrometers in diameter. Smoke impacts are not related only to acreage burned, but to vegetation type, fuel loading and weather conditions, among other factors. For example, grassland fires produce much less smoke per acre than do forest fuels. Even areas of similar vegetation types in forested areas may have significantly different amounts of emissions due to lower fuel load and smoke production in restored areas compared to areas that have missed several cycles of wildland fire and contain unnaturally heavy fuel loadings.

Healthy adults are not usually at risk from particulate matter; they may experience runny noses and coughing but these symptoms usually subside as the smoke disperses. People with heart or lung diseases, such as congestive heart disease, chronic obstructive pulmonary disease,

emphysema, or asthma can be at risk. People with these conditions may find it difficult to breathe, may cough, or feel short of breath after inhaling smoke from a prescribed burn or wildland fire. Children and the elderly are generally more susceptible to the harmful effects of smoke (CARB, 2003).

Most byproducts of wildland and prescribed fire combustion of health concern are concentrated at the fire line, and decrease to negligible levels in very short distances. Local weather patterns affect smoke mixing and movement, especially at night. Generally, the greater distance from the fire, the larger the volume of air available to dilute smoke below levels considered harmful to humans. Despite this apparent relative benefit, fine particulates also travel much greater distances from firelines, making them of most concern to public health.

Firefighters are exposed to the highest health risk from smoke on or near the firelines. The risks are well studied and include inhalation of carbon monoxide, hydrocarbons, and particulates. Standard firefighting practices are employed to minimize firefighter exposure. These practices include: planning the location of firelines to minimize exposure and rotating firefighters out of smoky segments of the fire line at frequent intervals. Firefighter safety may also be at risk, although prescribed burns are well planned and risks are minimal. Sources of risk, in addition to the fire itself, include tree felling, fire line construction, helicopter transport, and handling petroleum products.

Fire management personnel would be exposed to increasingly hazardous conditions at the Seashore over time as fuels continue to accumulate in untreated areas of the parks and the risk of high severity fire grows. Efforts at direct attack or suppression of intense fires can become increasingly difficult the hotter and quicker a fire burns.

Because Alternative A would only result in a maximum of 500 acres burned each year, impacts to fire fighting personnel, visitors and community members from smoke would remain short-term and minor. However, this alternative would do relatively less than the other alternatives to address the continued accumulation of fuels in the park, and the risk of a large and hot wildfire similar to the Vision Fire. Should such a fire burn, both health and safety may be seriously threatened.

Wildland Fire and Suppression

Wildland fires on average burn less than 30 acres at the Seashore each year. Although the location at which these fires may burn is not controlled, they are quickly suppressed and are small. Therefore the smoke impacts from average wildland fires to visitors, community members, or firefighting personnel would be short-term, minor, and localized.

Mechanical Treatment

Up to 500 acres of land would be mechanically thinned, some of it to reduce accumulated fuels. To the extent that the risk of a catastrophic fire is reduced by mechanical treatment, some negligible benefit to long-term safety and human health is possible, as both the risk of injury from the fire itself and to human health from inhaling smoke would be reduced. Mechanical

treatment projects in the Limantour, Highway One, and Bolinas Ridge FMUs would also improve safety to responding firefighters by reducing fuels along existing fire roads and creating zones of reduced fuels to impede wildfire spread.

Any potential safety impacts to visitors from equipment use would be eliminated or minimized through posted closures during mechanical treatment.

Public Education and Research/Fire Cache Construction

Public education, fire research, and the building of a fire cache would all have beneficial, long-term impacts on human health and safety. Public education would provide timely information on fire management actions and inform the public about prescribed or wildland burns and closures. Research could help in providing guidance on how to best avoid smoke or danger to residents or fire fighters. Locating a cache closer to other park administrative offices would reduce response time. Together, these offer negligible to minor benefits to human health and safety.

Cumulative Impacts

The projects listed in Appendix C would not have adverse impacts to human health and safety. However, a large-scale wildfire such as the Vision Fire could have a short-term adverse major effect on the health and safety of firefighters, visitors, and local communities.

A large wildfire has the potential to increase the exposure of visitors, employees, and communities to ground level smoke, particularly during late night and morning periods when smoke plumes collapse, descend and concentrate in low-lying areas or canyon bottoms. Wildland fires similar to those in 1999, when numerous wildland fires were burning simultaneously throughout northern California could affect the park and, thus, the health and safety of visitors and park employees for several weeks.

During catastrophic fires, large fire organizations would be employed to control the fire, as needed. When this occurs, a larger amount of equipment, including helicopters and fire engines, would be used to accomplish fire control objectives. Complex fire operations can extend their activities over large areas, sometimes tens of thousands of acres. An increase in the number and extent of suppression fires would cause an increase in the rate of exposure of fire personnel to hazardous conditions - both fire and smoke. This exposure would be unplanned with the potential for a higher rate of injury to firefighters and the public. Efforts at direct attack or suppression of intense fire would also pose a threat to firefighter safety due to the nature of such activities. Additional hazards of fighting wildfires include fire line construction, tree falling, helicopter transport, direct flame exposure, and respiratory problems due to smoke inhalation. To help mitigate impacts, firefighters would be frequently rotated and allowed to rest or sleep when needed, and firelines would be used to minimize exposure. Even with these mitigation measures, exposure to risk from the fire itself and from heavy smoke to firefighter, visitors and community members could be major and adverse during the time the fire is burning.

Conclusion

The actions of this alternative would have direct adverse, short-term, and minor impacts upon the health and safety of both the public and firefighters, except during large, high severity fire events, when the proximity of people to smoke and flame would result in major, short-term, and unavoidable adverse impacts. Alternative A minimizes smoke impacts in the short-term, but offers no more than negligible benefits in addressing the continued accumulation of fuels that is a wildfire risk to adjacent communities.

Public education, fire research, and fire cache construction would provide minor benefits by informing the public of prescribed burns and by reducing response time and increasing response effectiveness.

Alternative B

Analysis

The impacts of this alternative on human health and safety would be similar to that of the No Action (Alternative A), except in the following areas:

Prescribed Fire

Double the acreage burned in Alternative A would be treated with prescribed fire. The same types of impacts identified in Alternative A, e.g., inhalation of smoke and particularly of fine particulates by visitors or community members, and of carbon monoxide, hydrocarbons, and particulates by firefighters, would occur. Because more acreage would be burned, the chances of exposure to visitors, employees and the public would be greater. This would particularly be true of ground level smoke, especially during late night and morning periods when smoke plumes collapse, descend and concentrate in low-lying areas or canyon bottoms.

Firefighters would be exposed to the same type of impacts from fire and smoke as described above over a wider acreage. Fire line construction, tree falling, and firing operations would be conducted in a relatively safe and orderly fashion compared to a wildland burn, and prescribed fires are generally of lower intensity and less threatening than wildfires. However, risks would remain, as they would from handling petroleum products and other tasks associated with preparing for and conducting prescribed burns. Although treated acreage would be doubled, mitigation described above would minimize impacts. Injuries may increase, but the rate of such an increase is not possible to predict with any certainty.

Both public and firefighter exposure to wildfire hazards, including smoke, would be progressively reduced over time because of the reduction in fuels associated with the prescribed burning of up to 1,000 acres. The effect would be minor to moderate and long-term.

Wildland Fire and Suppression

Overall, there is no expected increase in fire-caused injuries to visitors, employees, and the public due to current suppression activities that average 30 acres per year.

Mechanical Treatment

Double the acreage in Alternative A would be mechanically treated in this alternative. Mechanical treatment (expanded to 1000 acres) would occur which has the potential to increase the exposure of visitors, employees, and the public to equipment activity. However, because areas to treated are to be temporarily closed, any increase in direct impacts to human health and safety would be short-term and minor.

Mechanical treatment in the Limantour, Highway One, Inverness Ridge, Wilderness North and South, Bolinas Ridge, and Palomarin FMUs would improve safety to responding firefighters, reduce fuels along existing fire roads and create zones of reduced fuels to impede fire spread.

Public Education, Fire Research, and Fire Cache Construction

No differences beyond those identified in Alternative A would occur.

Under this Alternative, fire personnel would be exposed to additional hazards in their work above Alternative A. The effect would be minor, short-term, but greater than Alternative A.

Cumulative Impacts

No cumulative impacts beyond those described under Alternative A would be expected.

Conclusion

Alternative B would have direct adverse, short-term, and minor impacts upon the health and safety of both the public and firefighters, except during large, high severity fire events, when the proximity of people to smoke and flame would result in major, short-term, and unavoidable adverse impacts.

A minor to moderate long-term benefit to public and park staff health and safety greater than that in Alternative A from the reduction of fuels through both prescribed fire and mechanical thinning and reduction in the risk of catastrophic fire would occur.

Public education, fire research, and fire cache construction would provide minor benefits by informing the public of prescribed burns and by reducing response time and increasing response effectiveness.

Alternative C

Analysis

Prescribed Fire

Up to 2000 acres per year would be treated with prescribed burning in this alternative. The same types of impacts identified in Alternative A, e.g., inhalation of smoke and particularly of fine particulates by visitors or community members, and of carbon monoxide, hydrocarbons, and particulates by firefighters would occur. Because more acreage would be burned, the chances of exposure to visitors, employees and the public would be greater than in either Alternative A or B. This would particularly be true of ground level smoke, especially during late night and morning periods when smoke plumes collapse, descend and concentrate in low-lying areas or canyon bottoms. The public and firefighting personnel may also be at slightly greater risk of prescribed fire burning outside its prescription. If this happens, heavier fuel loads could burn with resulting increases in smoke. In the extreme, the fire itself could be threatening, although preparation and the presence of a crew and firefighting apparatus on site means the extent of an escape would be minimal.

Firefighters would be exposed to the same type of impacts from fire and smoke as described above over a wider acreage. Although treated acreage would be expanded, mitigation described above would minimize impacts. Injuries may increase, but the rate of such an increase is not possible to predict with any certainty.

Both public and firefighter exposure to wildfire hazards, including smoke, would be progressively reduced over time because of the reduction in fuels associated with the prescribed burning of up to 2,000 acres. Although this alternative would treat more acres through prescribed burning (and mechanical treatment), additional acreage over that identified in Alternative B may be treated not just to reduce fuels, but to enhance or protect natural and cultural resources. The degree of beneficial impact in reducing the risk and/or extent of a large and intense wildfire would therefore be somewhat, but not significantly greater than that if Alternative B were implemented.

Wildland Fire and Suppression

Overall, there is no expected increase in fire-caused injuries to visitors, employees, and the public due to current suppression activities that average 30 acres per year.

Mechanical Treatment

Up to 1500 acres per year would be mechanically treated each year under this alternative. The foci of mechanical treatment would be primarily to control the spread of invasive exotic species and to reduce the risk or potential for spread of a wildfire. Forests would be thinned prior to prescribed burning and a fuel break along Inverness Ridge would be maintained. In combination with the reduced fuel loads from prescribed burning described above, firefighters and the public

may experience a moderate benefit in the reduction of risk and extent of a large-scale and potentially dangerous wildfire.

As in other alternatives, closures and public information would prevent or minimize any impacts to the public from mechanical thinning or mowing equipment.

Public Education, Fire Research, and Fire Cache Construction

No differences beyond those identified in Alternative A would occur.

Under this Alternative, fire management personnel would be exposed to hazards of firefighting, smoke inhalation and the use of mechanical equipment over more acreage than in either of the other alternatives.

Cumulative Impacts

No cumulative impacts beyond those described under Alternative A would be expected.

Conclusion

Alternative C would have direct adverse, short-term, and minor impacts upon the health and safety of both the public and firefighters, except during large, high severity fire events, when the proximity of people to smoke and flame would result in major, short-term, and unavoidable adverse impacts.

A moderate benefit to public and park staff health and safety greater than that in Alternative B from the reduction of fuels through both prescribed fire and mechanical thinning and reduction in the risk of catastrophic fire would occur.

Public education, fire research, and fire cache construction would provide minor benefits by informing the public of prescribed burns and by reducing response time and increasing response effectiveness.

SOCIOECONOMIC IMPACTS

Alternative A

Impacts on Regional Economy

Under this alternative, the fire management program may have both direct and indirect impacts on the local economy (West Marin County) that is primarily driven by tourism spending. Direct impacts include the park's transactions with local businesses that supply goods and services for fire management activities. Additional direct impacts come from employees on the fire program payroll who procure personal housing, food, goods, and services from local businesses. Indirect impacts include the impact of fire management activities on tourism.

The analysis in this section primarily evaluates the costs and jobs associated with the core fire program envisioned under each alternative and compares it to the local economy. The core fire program includes preparedness and initial attack suppression capabilities and the costs associated with implementing a prescribed fire and mechanical treatment program. The analysis also compares the potential impacts of the actions proposed on the local economy and the potential loss or creation of jobs.

As noted in the Affected Environment, Point Reyes National Seashore received 2.35 million visitors in 2000 accounting for 930 travel party days/nights in the area. An average visitor party spends $94 per party per night in the local area ($109 if locals excluded). Total visitor spending was $87 million in 2000, $80 million excluding local visitors. This spending of visitors from visitors from outside the local region generates $69 million in sales by local tourism businesses, yielding $25.6 million in direct income and supporting 1,100 jobs. Each dollar of tourism spending yields another $.63 in sales through the circulation of spending within the local economy. Including these secondary effects, the total economic impact of tourism on the local economy is $113 million in sales, $42 million in wages and salaries, and 1,800 jobs (Michigan State University, 2001).

Under Alternative A, overall fire funding for operations is estimated at approximately $770,000 annually for wildfire suppression, mechanical treatments and prescribed fire. For the last three years, Point Reyes and GGNRA have received an additional $700,000 annually for Wildland Urban Interface (WUI) projects in the local community. Staffing for all aspects for fire management is approximately 13 Full Time Equivalents (FTEs; one person for a work year) (Wong, 2003). Employees may contribute to the economy as well by renting or buying housing and purchasing goods and services locally. Compared to the existing $155 million benefits of tourism overall, an additional $1.5 million would have only minor beneficial impacts. This is also true with jobs, as 13 staff compared to the 1,800 jobs created by tourism would have only minor benefits on the local economy. In addition, the 13 fire employees created compared to the 120,000 jobs in Marin County indicates beneficial impacts are minor (Marin County, 2003).

In any agency EIS, a section analyzing any impacts to minority or low-income populations from the proposed actions is required. The actions proposed in this alternative, including prescribed fire, mechanical treatment, and suppression of small or large wildfires, would have no disproportionate impact on minorities or low-income populations. In fact, most of the homes in the vicinity of the park are in the half-million dollar and up range.

Prescribed Fire Impacts on Local Economy

Under this alternative, 500 acres/year would be treated with prescribed fire. Based on past prescribed fires conducted at PRNS over the past 15 years, this Alternative would not result in the closure of any areas (usually 200 acres or less) for more than one or two days. Therefore, any adverse economic impacts from prescribed fire to tourism are short-term, negligible to the local economy. Some portion of the fire management budget and staffing is attributable to prescribed fire, with resulting negligible to minor beneficial impacts from fire operations spending, jobs and the purchase of goods and services by fire management staff.

Unplanned Ignitions, Wildfire, and Suppression Impacts on Local Economy

The park relies heavily on Marin County Fire Department for structural fire and wildland fire protection. The NPS is considered support and back up for large-scale events. In past years, unplanned ignitions (except large-scale fires) have not impacted the regional economy or the visitor population of the park. However, there have been short-term negligible impacts due to minor closures of areas during suppression for short periods, usually less than one day.

Under any of the alternatives, the build-up of fuels would continue as no alternative treats the entire study area; therefore, a large-scale wildfire at infrequent intervals in always a possibility. Socioeconomic impacts of such a fire may be similar to those associated with the Vision Fire in 1995. It consumed 48 homes and damaged an additional 18, resulting in property damage to structures estimated at $37 million. The economic impact to business is estimated to have been $1.365 million. The estimated for public service recovery (includes road repairs, water control facility repairs, debris removal, emergency protection measures) was estimated at $1.781 million. The total economic loss estimate was $40.146 million. Total suppression costs were estimated at $6.4 million (Marin County Fire Department, 1995).

Mechanical Treatments Impacts of Local Economy

Under this alternative, 500 acres/year at FMUs Estero, Limantour Road, Highway One, and Bolinas Ridge would be treated by mechanical means. Tomales Point, Headlands Inverness Ridge, Wilderness North, Wilderness South, Palomarin would only receive actions common to all alternative such as road maintenance and defensible space around structures. This level of treatment would not have a measurable effect on the regional economy or the visitor population. However, there have been short-term negligible impacts to the visitor experience and possibly therefore to the tourism economy due to minor closures of areas during mechanical treatment for safety reasons. As in prescribed burning, some portion of the fire management budget and staffing is attributable to mechanical treatments, with resulting negligible to minor beneficial impacts from fire operations spending, jobs and the purchase of goods and services by fire management staff.

Fire Information/Education on Local Economy

There are no beneficial or adverse impacts anticipated under this alternative.

Fire Cache/Park Headquarters Relocation, and Construction on Local Economy

The construction of a fire cache at Bear Valley would have a one-time cost of approximately $500,000. This would have a one-time beneficial, minor, economic effect on the local economy in terms of jobs and one time funding. .

Fire Effects and Fuel Management Research

There are no beneficial or adverse impacts to the local economy anticipated under this alternative.

Cumulative Impacts

Based on an analysis of the list of projects in Appendix C, the cumulative impacts of all the projects listed with this proposed action would have a beneficial minor effect on the local economy by the influx of some additional federal funding and a few jobs.

A large-scale wildfire that may or may not include land inside the project area would have a short-term adverse moderate effect on the regional economy and visitor population. For example, parts of the park could be closed for up to two months for rehabilitation, resulting in moderate negative impact to the local economy. In addition, the total damage to structures and public facilities resulting from the Vision Fire was estimated $40.146 million. Therefore, a large-scale fire would have a major impact on the local economy, both beneficial and adverse. The Vision Fire, for example, created a building surge due to reconstruction of the lost structures; however, as noted above, several homes were lost and millions spent to suppress the fire.

Conclusions

Under Alternative A, direct fire funding and staffing would have minor, long-term, beneficial impacts compared to dollars and staff positions generated from tourism in the local economy. No disproportionate impacts to low-income or minority populations would occur.

The prescribed burn program is not expected to result in more than very short-term closures of small areas, with no or negligible adverse impacts on tourism and the local economy. Areas may be closed during mechanical treatment, which because it lasts longer, may result in negligible to minor short-term impacts to tourism and the local economy.

In past years, unplanned ignitions (except large-scale fires; see cumulative impacts) have not impacted the regional economy or the visitor population of the park. However, there have been short-term, negligible impacts to the local economy due to minor closures of areas during suppression for short periods (less than one day).

Additional building and other projects in the Seashore would have a minor beneficial cumulative effect on the local economy. Cumulative effects from a larger wildfire, should it occur, could be major and both adverse and beneficial. Adverse impacts would result from the loss of property and money spent to suppress the fire, but benefits would also result from rebuilding and the influx of federal money.

Alternative B

Impacts on Regional Economy

Under Alternative B the number of acres treated by both prescribed burning and mechanical treatment would double to up to 1000 acres/year. Suppression activities would remain the same as in Alternative A. Based on the analysis, operating funds for fire management under this

option would increase by $211,000 to about $1.7 million. Three additional jobs, or 16 FTEs would be created compared to No Action. With this level of spending and comparing it the jobs (1,800) and economic benefits of tourism ($155 million), direct fire operations spending and job creation has a beneficial long-term, but minor impact of the local economy. However, compared to No Action, spending would increase by 13%, and 23% more fire management personnel would be required. Compared to the entire regional economy, these increases would be negligible or minor; compared to the park's fire management operations in Alternative A, they would be minor to moderate increases.

The actions proposed in this alternative, including prescribed fire, mechanical treatment, and suppression of small or large wildfires, would have no disproportionate impact on minorities or low-income populations.

Prescribed Fire Impacts on Local Economy

Under this alternative, 1000 acres/year would be treated with prescribed fire. Based on past prescribed fires conducted at PRNS over the past 15 years, this alternative would not result in the closure of any areas (usually 200 acres or less) for more than one or two days. Therefore, any adverse impacts to the local economy from prescribed fire are short-term and negligible. This alternative would add some portion of the $1.7 million fire management budget to the local economy, and some or all of the 16 staff would spend money in the local communities for goods and services. While this is a minor benefit compared to spending overall in neighboring communities, it is possibly as much as a moderate benefit compared to these features of the No Action alternative.

Unplanned Ignitions, Wildfire, and Suppression Impacts on Local Economy

No changes in impacts from the implementation of Alternative B compared to Alternative A are expected.

Mechanical Treatments Impacts of Local Economy

Under this alternative, double the acres treated in No Action would be mechanically thinned. This level of treatment would not have a measurable effect on the regional economy or the visitor population. However, there have been short-term negligible impacts to the visitor experience and possibly therefore to the tourism economy due to minor closures of areas during mechanical treatment for safety reasons. Based on past experience in the park, visitors use other park areas with small areas are closed and do not leave the park; therefore impacts from reductions in tourism spending would not be more than negligible. As in prescribed burning, some portion of the fire management budget and staffing is attributable to mechanical treatment, with resulting beneficial impacts from fire operations spending, jobs and the purchase of goods and services by fire management staff. Although these would be negligible or minor compared to total local spending, they may be moderate benefits compared to similar spending conducted under No Action.

Fire Information/Education on Local Economy

As in Alternative A, there would be no beneficial or adverse impacts anticipated under this alternative.

Fire Cache/Park Headquarters Relocation, and Construction on Local Economy

As in Alternative A, construction of the fire cache would have a one-time beneficial, minor, economic effect on the local economy in terms of jobs and one time funding.

Fire Effects and Fuel Management Research

As in Alternative A, there would be no beneficial or adverse impacts to the local economy resulting from research.

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Cumulative Impacts

No additional cumulative impacts beyond those described under Alternative A are anticipated if Alternative B were implemented.

Conclusions

Under Alternative B, direct fire funding and staffing would have minor, long-term, beneficial impacts compared to dollars and staff positions generated from tourism in the local economy. Compared to spending in No Action, these benefits may be more moderate. No disproportionate impacts to minority or low-income populations would occur.

The prescribed burn program is not expected to result in more than very short-term closures of small areas, with no or negligible adverse impacts on tourism and the local economy. Areas may be closed during mechanical treatment, which because it lasts longer, may result in negligible to minor short-term impacts to tourism and the local economy.

In past years, unplanned ignitions (except large-scale fires; see cumulative impacts) have not impacted the regional economy or the visitor population of the park. However, there have been short-term, negligible impacts to the local economy due to minor closures of areas during suppression for short periods (less than one day).

Additional building and other projects in the Seashore would have a minor beneficial cumulative effect on the local economy. Cumulative effects from a larger wildfire, should it occur, could be major and both adverse and beneficial. Adverse impacts would result from the loss of property and money spent to suppress the fire, but benefits would also result from rebuilding and the influx of federal money.

Alternative C

Impacts on Regional Economy

Under Alternative C, actions include prescribed burn projects encompassing up to 2000 acres/year, mechanical treatment projects covering up to 1500 acres/year and a suppression program. Operating funds for fire management under this option would increase by $230,000 and five extra fire jobs would be created. With this level of spending and comparing it the jobs (1,800) and economic benefits of local tourism ($155 million), direct fire operations spending and job creation has a beneficial long-term, but minor impact of the local economy. However, compared to No Action, this is a 15% increase in direct spending and an increase of 38% in staffing. These benefits are moderate compared to No Action.

The actions proposed in this alternative, including prescribed fire, mechanical treatment, and suppression of small or large wildfires, would have no disproportionate impact on minorities or low-income populations.

Prescribed Fire Impacts on Local Economy

Under this alternative, 2000 acres/year would be treated with prescribed fire. Based on past prescribed fires conducted at PRNS over the past 15 years, this alternative would not result in the closure of any areas (usually 200 acres or less) for more than one or two days. Therefore, any adverse impacts to the local economy from prescribed fire are short-term and negligible. This alternative would add some portion of the $1.8 million fire management budget to the local economy, and some or all of the 18 staff would spend money in the local communities for goods and services. While this is a minor benefit compared to spending overall in neighboring communities, it is likely a moderate benefit compared to these features of the No Action alternative.

Unplanned Ignitions, Wildfire, and Suppression Impacts on Local Economy

No changes in impacts from the implementation of Alternative C compared to Alternative A are expected.

Mechanical Treatments Impacts of Local Economy

Under this alternative, triple the acres treated in No Action would be mechanically thinned. This level of treatment would not have a measurable effect on the regional economy or the visitor population. However, there have been short-term negligible impacts to the visitor experience and possibly therefore to the tourism economy due to minor closures of areas during mechanical treatment for safety reasons. Based on past experience in the park, visitors use other park areas with small areas are closed and do not leave the park; therefore impacts from reductions in tourism spending would not be more than negligible. As in prescribed burning, some portion of the fire management budget and staffing is attributable to mechanical treatment, with resulting beneficial impacts from fire operations spending, jobs and the purchase of goods and services by fire management staff. Although these would be negligible or minor compared to total local

spending, they would be moderate benefits compared to similar spending conducted under No Action.

Fire Information/Education on Local Economy

As in Alternative A, there would be no beneficial or adverse impacts anticipated under this alternative.

Fire Cache/Park Headquarters Relocation, and Construction on Local Economy

As in Alternative A, construction of the fire cache would have a one-time beneficial, minor, economic effect on the local economy in terms of jobs and one time funding.

Fire Effects and Fuel Management Research

As in Alternative A, there would be no beneficial or adverse impacts to the local economy resulting from research.

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Cumulative Impacts

No additional cumulative impacts beyond those described under Alternative A are anticipated if Alternative C were implemented.

Conclusions

Under Alternative C, direct fire funding and staffing would have minor, long-term, beneficial impacts compared to dollars and staff positions generated from tourism in the local economy. Compared to spending in No Action, these benefits are likely to be moderate. No disproportionate impacts to minority or low-income populations would occur.

The prescribed burn program is not expected to result in more than very short-term closures of small areas, with no or negligible adverse impacts on tourism and the local economy. Areas may be closed during mechanical treatment, which because it lasts longer, may result in negligible to minor short-term impacts to tourism and the local economy.

In past years, unplanned ignitions (except large-scale fires; see cumulative impacts) have not impacted the regional economy or the visitor population of the park. However, there have been short-term, negligible impacts to the local economy due to minor closures of areas during suppression for short periods (less than one day).

Additional building and other projects in the Seashore would have a minor beneficial cumulative effect on the local economy. Cumulative effects from a larger wildfire, should it occur, could be major and both adverse and beneficial. Adverse impacts would result from the loss of property and money spent to suppress the fire, but benefits would also result from rebuilding and the influx of federal money.

MANDATORY SECTIONS

The following is a summary of three types of impacts that is required by the NEPA regulations that apply to all agencies. The first describes what each alternative sacrifices in terms of long-term sustainability to achieve short-term gain. The second section discusses the commitment of any irreversible (permanent loss or non-renewable resource) or irretrievable (short-term loss or loss of renewable resource) commitments of resource an alternative would require. The final section is a summary of any remaining more than minor adverse impacts that cannot be further mitigated.

Alternative A

Short-term Use Versus Long-term Enhancement of Resources

Fire management activities would result in some mortality of wildlife and vegetation, but would reduce threat of large, intense wildland fires. Short-term adverse impacts related to project activity would result in long-term beneficial impacts to restore more natural forest conditions. Without prescribed fire actions under Alternative A, the loss of fire as a factor in the long-term development of the forest ecosystem could adversely affect long-term productivity. Long-term adverse impacts are acceptable due to the beneficial impacts provided, and most long-term adverse impacts would be mitigated to less than significant. Prescribed fires may escape to become wildland fires. However, this risk is offset by the reduced risk of wildland fire ignition and high severity wildland fires when projects are completed.

Irreversible/Irretrievable Commitments of Resources

No irreversible/irretrievable commitments of resources would occur under Alternative A.

Unavoidable Adverse Impacts

Some native vegetation would be removed to reduce fuel levels and suppress wildland fires and indirectly affect wildlife. These adverse impacts are short-term and would be mitigated to a minor to moderate impact. Mitigation measures would minimize exotic plant species introduction and expansion, however, some adverse impact would still occur.

Alternative B

Short-term Use Versus Long-term Enhancement of Resources

Fire management activities under Alternative B that are greater than Alternative B and occur in more areas in the park would result in some mortality to wildlife and vegetation, but would reduce threat of large, intense, wildland fire (more than Alternative B). Short-term impacts related to project activity would restore more natural forest conditions and have long-term benefits to the natural ecosystem preservation. Prescribed fires may escape to become wildland fires. However, this risk is offset by the reduced risk of wildland fire ignition and high severity wildland fires when projects are completed.

Irreversible/Irretrievable Commitments of Resources

No irreversible/irretrievable commitments of resources would occur under Alternative B.

Unavoidable Adverse Impacts

Some native vegetation and wildlife would be adversely impacted to reduce fuel levels and suppress wildland fires. Mitigation measures should minimize any adverse impacts to minor or moderate over the long-term. Exotic plant species introduction and expansion would be mitigated to reduce any adverse impacts; however, some impact would still occur. Expanded prescribed burning (spring burns) could result in decreased reproduction of herbaceous species, depending on plant stage of development, phenology, and timing.

Alternative C

Short-term Use Versus Long-term Enhancement of Resources

Fire management activities under Alternative C would result in some mortality, but would greatly reduce threat of large, intense, wildland fire over the long run. This Alternative treats 3,500 acres per year. Short-term impacts related to project activity would restore more natural forest conditions and have long-term benefits to ecosystem preservation. Prescribed fires may escape to become wildland fires. However, this risk is offset by the reduced risk of wildland fire ignition and high severity wildland fires when projects are completed.

Irreversible/Irretrievable Commitments of Resources

No irreversible/irretrievable commitments of resources would occur under Alternative C.

Unavoidable Adverse Impacts

Some native vegetation would be removed to reduce fuel levels and suppress wildland fires and some associated wildlife would be adversely impacted. Mitigation measures would minimize any impacts to both vegetation and wildlife. Mitigation measures would minimize exotic plant species introduction and expansion, however, some adverse impact would still occur. Expanded spring burning and natural resource prescribed burning could result in decreased reproduction of herbaceous species, depending on plant stage of development, phenology, and timing. However, altering the timing of the burn to increase native species as research is conducted would mitigate these impacts.